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INSTRUCTION MANUAL

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TYPE 561A
OSCILLOSCOPE

MANUFACTURERS OF CATHODE-RAY OSCILLOSCOPES

17779

INSTRUCTION MANUAL

TYPE 561A OSCILLOSCOPE

Tektronix, Inc.
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070-342

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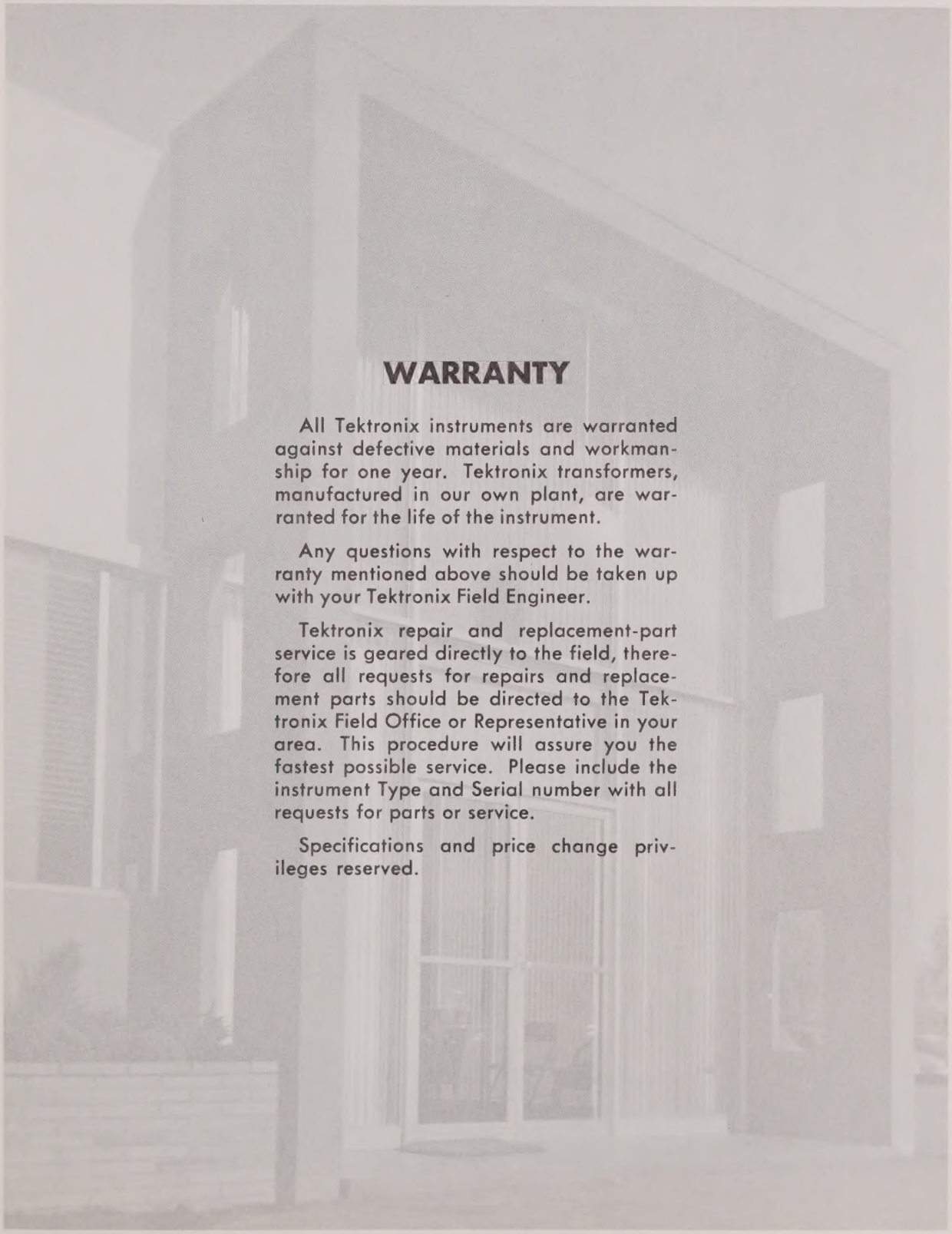

WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our own plant, are warranted for the life of the instrument.

Any questions with respect to the warranty mentioned above should be taken up with your Tektronix Field Engineer.

Tektronix repair and replacement-part service is geared directly to the field, therefore all requests for repairs and replacement parts should be directed to the Tektronix Field Office or Representative in your area. This procedure will assure you the fastest possible service. Please include the instrument Type and Serial number with all requests for parts or service.

Specifications and price change privileges reserved.

TYPE 561A OSCILLOSCOPE
SERIAL
CRT
FOCUS
INTENSITY
ALIGNMENT
ASTIGMATISM
CALIBRATOR
PEAK-TO-PEAK
mVOLTS
VOLTS
CAL OUT
OFF
SCALE ILLUM.
POWER ON
TEKTRONIX, INC., PORTLAND, OREGON, U.S.A.
HORIZONTAL
VERTICAL
TYPE 3A1
DUAL-TRACE AMPLIFIER
VARIABLE VOLTS/DIV
POSITION
DC BAL
UNCAL
CH 1
CH 2
MODE
ALTER
CHOP
ADDED
TRIGGER
CH 1 ONLY
PULL
SERIAL
TEKTRONIX, INC.
PORTLAND, OREGON, U.S.A.
TYPE 2B67
TIME BASE
CALIBRATION
VARIABLE TIME/DIV.
mSEC
μSEC
SEC
STABILITY
READY
RESET
SINGLE SWEEP
NORM
EXT. INPUT
TRIGGERING
LEVEL
SLOPE
COUPLING
SOURCE
AUTO
INT
LINE
EXT
TRIG.
CALIBRATED

Section 1
Characteristics

General Information

The Tektronix Type 561A Oscilloscope is essentially an indicator unit with provision for two of a number of plug-in units. The plug-in unit in the right-hand opening controls the horizontal (X-axis) deflection, and the plug-in unit in the left-hand opening controls the vertical (Y-axis) deflection. The plug-in units can be selected from any of the Tektronix '2' Series or '3' Series groups to provide the desired oscilloscope performance.

Bandpass, Risetime, Vertical Deflection Factors, Input Impedance, and Sweep Rates are determined by the plug-in units used.

Cathode-Ray Tube

Type — T561 (rectangular ceramic-envelope).

Phosphor — P31.

Unblanking —Deflection type, dc-coupled, with grid intensification.

Graticule — Variable edge lighted "no parallax" internal graticule. Marked in 8 vertical and 10 horizontal divisions with each major division divided into 5 minor divisions on centerline.

Accelerating potential — 3.5 kv.

Usable viewing area — 8 divisions vertical by 10 divisions horizontal.

Deflection plate sensitivities — 18.5 to 20.5 volts per division vertical, and 17.5 to 19.3 volts per division horizontal.

Calibrator

Waveform — Square waves at the line frequency.

Output voltage — 0.2 millivolt to 100 volts, peak-to-peak, in 18 steps.

Accuracy — Peak-to-peak amplitude within 3% of indicated voltage.

Risetime — Typically 6 microseconds, or less.

Power Supplies

Electronically regulated for stable operation with widely varying line voltages and loads.

Line voltage requirements — 105 to 125 volts, or 210 to 250 volts, rms, 50 to 400 cps, single-phase ac.

Fuse — 2-amp slow-blowing type for 117 volts, 1-amp slow-blowing type for 234 volts.

Ventilation

Convection air cooled. Thermal cutout interrupts instrument power in the event of overheating.

Construction

Aluminum-alloy chassis and 2-piece cabinet.

Photo-etched anodized panel, blue vinyl paint over textured aluminum on cabinet.

Dimensions — Height 13½ inches, width 9¾ inches, and depth 21½ inches.

Weight — 30½ pounds, indicator unit only.

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NOTES

Section 2
Operating Instructions

Introduction

Before operating the Type 561A Oscilloscope, be sure that the instrument will cool properly, the proper line voltage is used, and the crt deflection potentials are correct.

Cooling

The air must be able to flow freely around the instrument so that it may cool. Vacuum tubes should not be operated with envelope temperatures above 150° C when the ambient temperature is at 25° C, or above 175° C when the ambient temperature is at 50° C. The Type 561A can operate in ambient temperatures up to 50° C. If the instrument overheats, the thermal cutout will turn off the power.

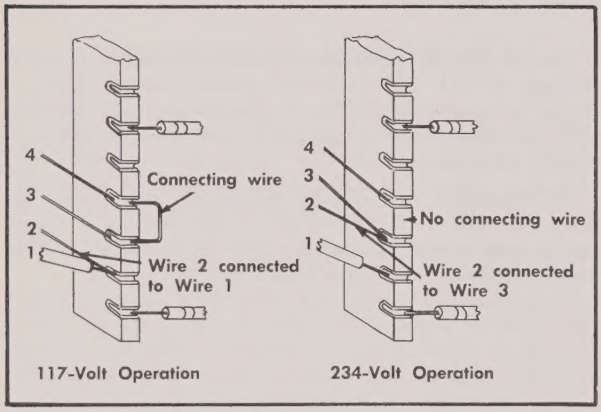


Fig. 2-1. Power transformer primary connections for operation of Type 561A Oscilloscope at 117 or 234 volts.

Line Voltage

The Type 561A instrument can be wired for either 117-volt or 234-volt operation. It will operate properly between 105 and 125 volts when wired for 117-volt operation, and between 210 and 250 volts when wired for 234-volt operation. A small metal tag on the rear of the instrument indicates the voltage for which it is wired at the factory.

Converting from one operating voltage to another requires a change in the power transformer primary connections, the fuse, and the male line cord plug.

Fig. 2-1 indicates the transformer primary connections for 117-volt and 234-volt operation. A 3-amp slow-blowing type fuse is required for 117-volt operation, and a 1.6-amp slow-blow type fuse is required for 234-volt operation.

Deflection Plate Voltages

The Type 561A may be operated with only one plug-in unit if desired. For example, moving film recording may be used in place of a sweep plug-in unit. However, it will be necessary to elevate the unconnected crt deflection plates to about +180 to +210 volts dc, to obtain proper focus and astigmatism control.

Blank Chassis

Blank-chassis plug-in units are available from your local Tektronix Field Office as Modification Kit number 040-245. Blank chassis permit you to build your own plug-in circuitry for use in the Type 561A.

Heat Dissipation — Plug-in unit circuitry should not elevate the instrument temperature above the limits discussed previously under Cooling.

Operation

Operation of the Tektronix Type 561A Oscilloscope with two plug-in units in place is much the same as that of a conventional Tektronix oscilloscope with corresponding vertical and horizontal deflection systems. The plug-in units take the place of the vertical and horizontal deflection systems in a conventional oscilloscope; their outputs connect directly to the deflection plates of the cathode-ray tube. The plug-in units can be selected to give the Type 561A Oscilloscope the degree and type of performance demanded of it by a particular application.

The front and back panels of the Type 561A have controls or switches that affect the display; however, the plug-in units determine the major characteristics of the display.

Front Panel

The POWER ON switch permits turning the instrument on or off.

The SCALE ILLUM. control permits adjustment of the brightness of the graticule markings.

The FOCUS control permits proper trace or spot focus for most intensity values.

The ASTIGMATISM control works in conjunction with the FOCUS control, and improves the focus over the entire crt display.

The INTENSITY control permits changing the crt display brightness.

The ALIGNMENT control permits electronically tilting the level of the crt trace to agree with the horizontal graticule markings.

The 18-position CALIBRATOR switch determines the peak-to-peak amplitude of the signal at the CAL. OUT connector. It also permits turning the CALIBRATOR off. The calibrator output is used to set the gain of the amplifier plug-in units and to check the basic timing of the time-base units.

Rear Panel

The CRT. CATHODE SELECTOR switch permits the operator to select either (1) internal DUAL-TRACE CHOPPED BLANKING to eliminate from the crt display any dual-trace chopped mode switching transients, or (2) external signals to be used for crt Z-axis intensity modulation.

The two binding posts located right above the CRT. CATHODE SELECTOR switch labeled EXT. CRT. CATHODE and GND. are the binding posts to be used in (2) above. Normally a metal strap is placed between the two binding posts. The strap must be removed from the EXT. CRT. CATHODE binding post when external Z-axis intensifying signals are used.

If the vertical plug-in unit does not have a dual-trace chopped mode of operation, leave the CRT. CATHODE SELECTOR switch in its up position. This connects the crt cathode circuit to ground for normal operation.

Changing Plug-In Units

To insert a plug-in unit into the Type 561A Oscilloscope, push it all the way into the opening. Then turn the aluminum knob, at the bottom center of the unit, clockwise until it is tight. To remove the unit, turn the knob counterclockwise several turns and pull.

Different plug-in units supply slightly different dc voltages to the crt deflection plates. Also, the Type 561A crt has a slightly higher horizontal deflection sensitivity than the vertical deflection sensitivity. Because of these differences, the plug-in unit gain should be adjusted when it is first inserted into the indicator. This is done by adjusting the GAIN ADJ., CALIBRATION, or SWEEP CAL. controls on the plug-in unit according to the instructions found in the corresponding plug-in unit instruction manual.

When the plug-in units are changed, the FOCUS and ASTIGMATISM controls on the Type 561A may have to be readjusted.

It is possible that only one plug-in unit may be used. When this is done, one set of crt deflection plates will not be connected to a plug-in. The unconnected deflection plates must have +180 to +210 volts connected to them to permit proper display focus and astigmatism control.

Display Combinations

The plug-in unit in the right-hand opening of the Type 561A controls the horizontal (X-axis) deflection of the crt beam. The unit in the left-hand opening controls the vertical (Y-axis) deflection.

To obtain the conventional display of a horizontal sweep with vertical deflection by the input signal, insert a time-base plug-in unit on the right and an amplifier unit on the left. If a vertical sweep is desired with the input signal displayed horizontally, insert the time-base unit on the left and the amplifier unit on the right. If an X-Y display is desired, insert amplifier type plug-in units in both plug-in openings.

Intensity Modulation

Intensity (Z-axis) modulation of the crt beam is possible through the EXT. CRT. CATHODE binding post on the rear of the instrument. Depending on the setting of the INTENSITY control, a negative pulse of 5 volts or more will turn on the crt beam.

To accomplish this, remove the ground strap from the EXT. CRT. CATHODE binding post, apply the Z-axis signal to the binding post, and set the CRT. CATHODE SELECTOR switch to the EXT. CRT. CATHODE position.

Section 3
Circuit Description

Introduction

The Tektronix Type 561A Oscilloscope contains a low-voltage power supply circuit, a cathode-ray-tube circuit, and a calibrator.

The low-voltage power supply circuit provides the regulated and unregulated power used by the instrument and the plug-in units.

The crt circuit contains the necessary controls and input facilities to present a sharp trace of desired intensity for displaying a signal. Two negative high-voltage power supplies provide the voltages for the crt cathode, focus element, and control grid.

Amplitude-calibrated square waves are produced by the calibrator.

LOW-VOLTAGE POWER SUPPLY

Power for the Type 561A Oscilloscope and its plug-in units is supplied through the power transformer T601. The two primary windings of T601 are connected in parallel for 117-volt operation, or in series for 234-volt operation, as shown on the schematic diagram.

The low-voltage power supply provides regulated outputs of —100, —12.2, +125, and +300 volts, and an unregulated output of +420 volts. Each circuit is a series-regulator type, employing silicon diodes for rectifiers. A series regulator circuit uses a vacuum tube (or transistor, in the case of the —12.2-volt supply) in series with the load. This tube controls the current through the load to maintain a constant voltage drop across the load. For example, if the load increases (resistance of load decreases) the series tube allows more current to flow; if the load decreases it allows less current to flow.

—100-Volt Supply

Reference voltage for the —100-volt supply is established by the gas diode, V609. The constant voltage drop across V609 establishes a fixed potential of about —85 volts at the grid of V634B. Voltage at the grid of V634A is established by the divider R616, R617, and R618. The difference in voltage between the two grids of V634 determines the plate current of V634A. Plate current of V634A determines the base voltage of transistor Q624 which in turn determines the grid voltage of the series tube, V627. The series tube controls the current through the load to hold the load voltage constant. R616, —100 V adjustment, determines the percentage of the total divider voltage applied to the grid of V634A and thus controls the output voltage. When this control is properly adjusted, the output is exactly —100 volts.

Should the output voltage tend to change because of a change in input voltage or a change in load current, the potential at the grid of V634A will change a proportional amount. Any change at the grid of V634A is amplified by V634A and Q624 and applied to the grid of V627. The resulting grid change at V627 will cause the load current to change in the direction needed to bring the output back to —100 volts. C616 improves the response of the regulator to sudden changes in output voltage.

+125-Volt Supply

The —100-volt supply serves as a reference for the +125-volt supply. With the lower end of R651 fixed at —100 volts, any change in the +125-volt output produces a proportional change at the grid of V654. This change is amplified and supplied to the grid of the series regulator tube, V667A. The change at the grid of V667A changes the load current in the manner needed to bring the output voltage back to a nominal +125 volts. C650 improves the response of the regulator to sudden changes in output voltage.

A small sample of the unregulated-bus ripple appears at the screen of V654 through R657. The ripple at the screen (which acts as an injector grid) produces a ripple at the grid of V667A which is opposite in polarity to the ripple at the plate of V667A. This tends to cancel ripple at the output. This same circuit also improves the regulation of the circuit in the presence of line voltage variation.

+300-Volt Supply

The +300-volt supply functions in the same manner as the +125-volt supply. To supply the voltage for the +300-volt regulator, rectified voltage from transformer terminals 21 and 22 is added to the voltage supplying the +125-volt regulator.

The +300-volt supply provides an unregulated output of +420 volts for the crt circuit.

—12.2-Volt Supply

Operation of the —12.2-volt regulating circuit is essentially the same as that of the other regulating circuits, except that transistors are used instead of vacuum tubes. The base of Q734 is fixed near —12 volts by the voltage divider R731-R732 between —100 volts and ground. Any variation of the —12.2-volt output at the emitter of Q734 is amplified by Q734 and Q744 to change the emitter-collector current of Q757 which is in series with the supply load. F720 protects the transistors in case of an overload on the —12.2-volt supply.

The collector of Q757 is connected to pin 5 of the Interconnecting Socket. This provides a return for this supply separate from the chassis and prevents large chassis currents.

CRT CIRCUIT

The crt circuit contains the cathode-ray tube and two high-voltage supplies (one for the crt cathode and focus element, the other for the control grid). The circuit also contains the necessary controls and signal input facilities.

Cathode-Ray Tube

A Tektronix T561 ceramic-envelope cathode-ray tube is used in the Type 561A. The accelerating potential is approximately 3500 volts, developed by about —3300 volts at the cathode and an average deflection plate voltage of about +200 volts. With this accelerating potential, the nominal vertical and horizontal deflection factors are 19.5 and 18.4 volts per centimeter respectively.

Deflection blanking of the crt beam is employed in the Type 561A. The crt contains a special set of deflection plates, pins 6 and 7, for this purpose. Both plates are connected to +125 volts; however pin 6 is also driven by the right-hand plug-in unit.

During sweep time, or if no plug-in unit is installed, both plates rest at +125 volts and permit the beam to pass on to the screen. During sweep retrace, however, pin 6 is driven considerably away from +125 volts. This scatters the beam and prevents it from reaching the screen.

High-Voltage Supplies

Energy for both high-voltage supplies is furnished by T801. V800, the primary of T801, and the circuit capacitance (shown by the dotted capacitor symbol on the schematic) form a Hartley oscillator which operates at about 45 kc.

One secondary winding of T801 provides voltage for the crt cathode and focus element. This voltage, rectified by V822, is about —3300 volts at the cathode, and between about —2000 and —3000 volts at the focusing element, depending on the setting of the FOCUS control. (The 6.3-volt crt heater is also elevated to the cathode potential.)

The output of the other secondary winding of T801 is rectified by V832 for the control grid. The grid voltage ranges from —3100 to —3400 volts, depending on the setting of the INTENSITY control. The reference to ground for this supply is determined by the voltage at the junction of diodes D838 and D839. The voltage at this junction, plus the setting of the INTENSITY control, determines the crt bias and therefore the intensity of the display.

Regulation of the high-voltage supplies is accomplished through feedback from the arm of R841. If, due to loading or a change in input voltage, the output of the high-voltage supply changes, a proportionate change occurs at the arm of R841. This change is amplified by V814 and is coupled to the screen grid of V800. A change at the screen of V800 will increase or decrease the amplitude of oscillations in V800. Thus the output voltage of T801 changes in the direction needed to return it to the desired level. The HIGH VOLTAGE control, R841, controls the output voltage by setting the bias on V814B.

Deflection Signals

Signals for the deflection plates are equal in amplitude but opposite in polarity (push-pull) and appear at pins 17 and 21 of the plug-in connector. The effective capacity these signals see at the connector affects the bandpass and phase shift through the plug-in. C760 and C761 (Plug-In Connectors diagram) are set at the factory for an effective deflection-plate capacity of 14.3 picofarads for each plug-in.

Intensifying Signals

Two signals may be used to modulate the intensity of the crt display. First, intensifying signals from a two-sweep (delaying-sweep) time-base plug-in unit are applied to the grid supply through pin 14 of the right-hand Interconnecting Socket. When the overall display intensity is reduced with the INTENSITY control, positive intensifying pulses from a two-sweep time-base unit will brighten any desired portion of the display. When using one-sweep time-base units, D838 serves as a low-impedance path for the crt grid power supply ground return. D839 prevents any positive voltage from the plug-in unit from affecting the power supply of the crt grid.

Two-sweep time-base units may couple a slightly negative voltage to the crt power supply from pin 14 of the plug-in via D839. This negative voltage is varied in a positive (toward ground) direction for trace intensification. D839 allows the intensifying voltage to rise, but limits it to ground potential.

C837 couples the fast-rising portion of the intensifying pulse to the crt grid for fast brightness changes when using a short duration intensified zone.

Crt Controls

The INTENSITY control, R835, has a range of about 300 volts to control the crt bias and permit changing the intensity of the display.

The FOCUS control, R844, adjusts the focus of the crt by varying the voltage at the focusing anode through a range from about —2000 to —3000 volts.

The ASTIGMATISM control, R864, has a 300-volt adjustment range.

The GEOMETRY control, R865, adjusts the geometry by varying the voltage of the crt isolation shield through a range from +180 to +246 volts.

CALIBRATOR

The calibrator for the Type 561A Oscilloscope produces a line-frequency amplitude-calibrated square wave.

The 6.3-volt (approximately 18 volts peak-to-peak) ac heater voltage for V884 is applied through C876 to the cathode of V884A, driving that tube into and out of cutoff at the line-frequency rate. The signal at the plate of V884A is then coupled to the grid of V884B to turn that tube on and off. Regenerative feedback from the plate of V884B to the grid of V884A speeds up the switching action of V884A.

The voltage present at the cathode of V884B during the time that V884B is conducting can be set to exactly 100 volts with the CAL. AMPL. adjustment, R871. The voltage divider in the cathode circuit of V884B contains precision resistors to provide an output accuracy of 3% or better at the various settings of the CALIBRATOR control.

Section 4
Maintenance

Introduction

If trouble occurs in the Type 561A Oscilloscope, a five-step procedure may be employed for repair. First the trouble must be confirmed. Next, the trouble is isolated to a plug-in unit or to the Type 561A. Trouble in the Type 561A is then localized to the Power Supply, Crt Circuit, or Calibrator. Troubleshooting the correct circuit will then determine which components are defective. The defective parts can then be replaced.

Confirmation of Trouble

Improper control settings may, at times, give indications of trouble. Therefore, if trouble is encountered in the instrument, you should be sure that it is not caused by improper front-panel control settings. For example, an improper setting of the SOURCE or COUPLING switch on a time-base unit can produce apparent triggering troubles; an improper setting of the VARIABLE control on an amplifier unit can produce an apparent decrease in sensitivity.

When it has been determined that trouble exists, it must be determined whether it is in one of the plug-in units or in the Type 561A indicator.

Isolating Trouble to Plug-In or Indicator

Isolating trouble to a plug-in unit or to the indicator can be done in one of two ways, depending on whether or not there are spare plug-in units available.

If trouble is found to be in the plug-in unit, refer to the instruction manual for that unit. A plug-in extension (part number 013-034, available from your local Tektronix Field Office) allows the units to be operated while extended out through the front of the oscilloscope opening.

Spare Plug-In Units Available

If more than two plug-in units are available, the easiest way to isolate trouble is to replace the plug-in units one at a time. The faulty unit can then be isolated by noting when proper operation is restored. If plug-in replacement does not correct the trouble, the Type 561A is probably faulty. NOTE: A non-sampling plug-in unit cannot be operated with a sampling plug-in unit.

Spare Plug-In Units Not Available

When spare plug-in units are not available, the crt display will be of great help. Trouble will normally show up as an erroneous display, or as no display at all. Since the crt display will help isolate the trouble, the following procedure is divided according to the type of display.

No Trace Or Spot. If no trace can be obtained on the crt, remove both plug-in units and vary the INTENSITY control. A spot should appear. If no spot appears, the trouble is in the Type 561A. If a spot does appear when both plug-in units are removed, reinsert each unit separately. After warmup, vary its POSITION control. If the spot or trace cannot be returned to the approximate center of the crt when a single plug-in unit is in the indicator, the trouble is probably in that unit.

Insufficient Vertical Deflection Or Improper Sweep Timing. If the plug-in unit front-panel gain controls do not permit adequate vertical deflection or proper sweep timing, check the low-voltage power supply and voltages at the cathode and grids of the crt (see schematics and Figs. 4-1 and 4-2).

If the power-supply voltages are not correct, remove both plug-in units and check the voltages again. If they still are not correct, the trouble is in the Type 561A indicator. If the power-supply voltages are correct with both plug-in units removed, but incorrect with only one of the two inserted, the trouble is in that unit. If the power supply voltages are correct with both plug-in units removed, but incorrect when either is inserted, the trouble is probably in the power supply of the Type 561A instrument.

Improper Triggering. If external triggering and line triggering are satisfactory, but internal triggering is not, the trouble is probably in the Trigger Pickoff Circuit of the amplifier plug-in unit. If satisfactory triggering cannot be obtained from any of the three sources (external, internal, or line) the trouble is probably in the time-base plug-in unit.

Waveform Distortion. If there is any waveform distortion, but no other indications of malfunction (such as improper sweep timing) the trouble is probably in the vertical plug-in unit.

Localizing Trouble In Type 561A Indicator

If it has been determined that trouble exists in the Type 561A, the location of the trouble can be further localized to the Power Supply, the Crt Circuit, or the Calibrator.

To localize the trouble to either the Power Supply or the Crt Circuit, measure the power-supply voltage at test points |1| through |4|, indicated in Fig. 4-1. If incorrect voltages are measured, the trouble is in the Power Supply or the power source. If all of the measured voltages are proper, the trouble is in the Crt Circuit.

Trouble in the Calibrator is indicated by an erroneous output at the CAL. OUT connector.

When it is known which circuit contains the trouble, that circuit can be checked to locate the defective component.

Circuit Troubleshooting

In troubleshooting a circuit, troubles such as broken wires, worn switches, scorched parts, and improperly seated tubes can be found by visual inspection. (Before a scorched part is replaced, the cause of the scorching should be eliminated.)

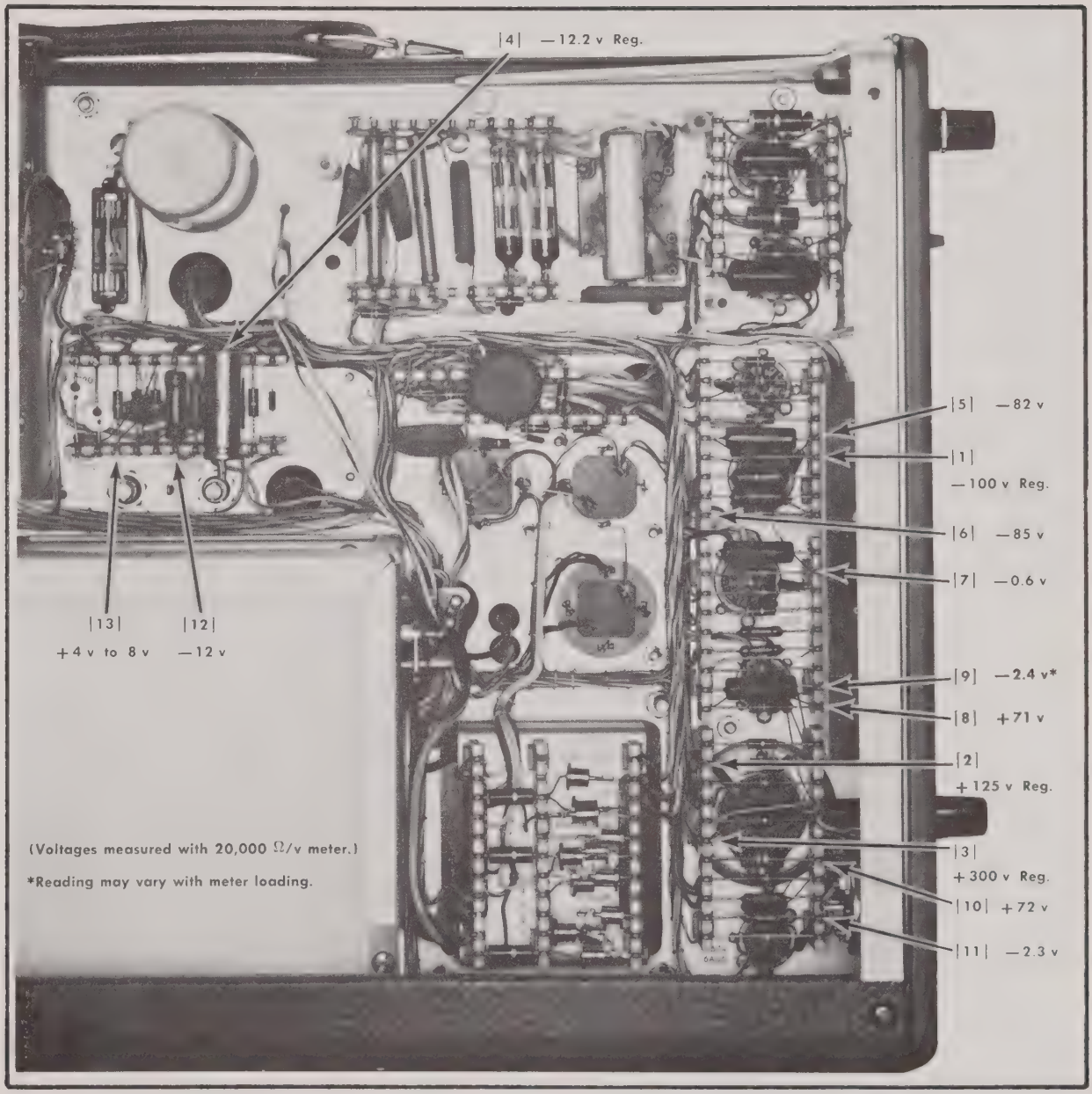


Fig. 4-1. Power-supply test points; [1] through [13]

Tube failure is the most prevalent cause of trouble in Tektronix instruments. Therefore, if a visual check fails to reveal the cause of trouble, all tubes should be checked as the next step. Tubes should be checked by substitution, one at a time. (Tube-testers cannot adequately check all parameters.) Be sure to return all good tubes to their original sockets; otherwise the instrument may have to be recalibrated unnecessarily because of different characteristics of the same tube type.

If tube substitution does not correct the trouble, then check the rest of the circuit by voltage and resistance measurements. Voltages at various points throughout the instrument are indicated on the circuit diagrams and in Figs. 4-1, 4-2 and 4-3. These voltages are typical nominals only and, with the exception of power-supply voltages, may vary considerably from instrument to instrument. Resistance measurements in a circuit will usually be point-to-point checks for which the proper values can be approximated from the schematic diagrams. Table 4-1 may be used as an aid in relating trouble symptoms to their probable cause and the procedure to use to locate the defective component. Voltages listed in the table were obtained with the Type 561A operated with Types 3A1 and 3B1 plug-in units.

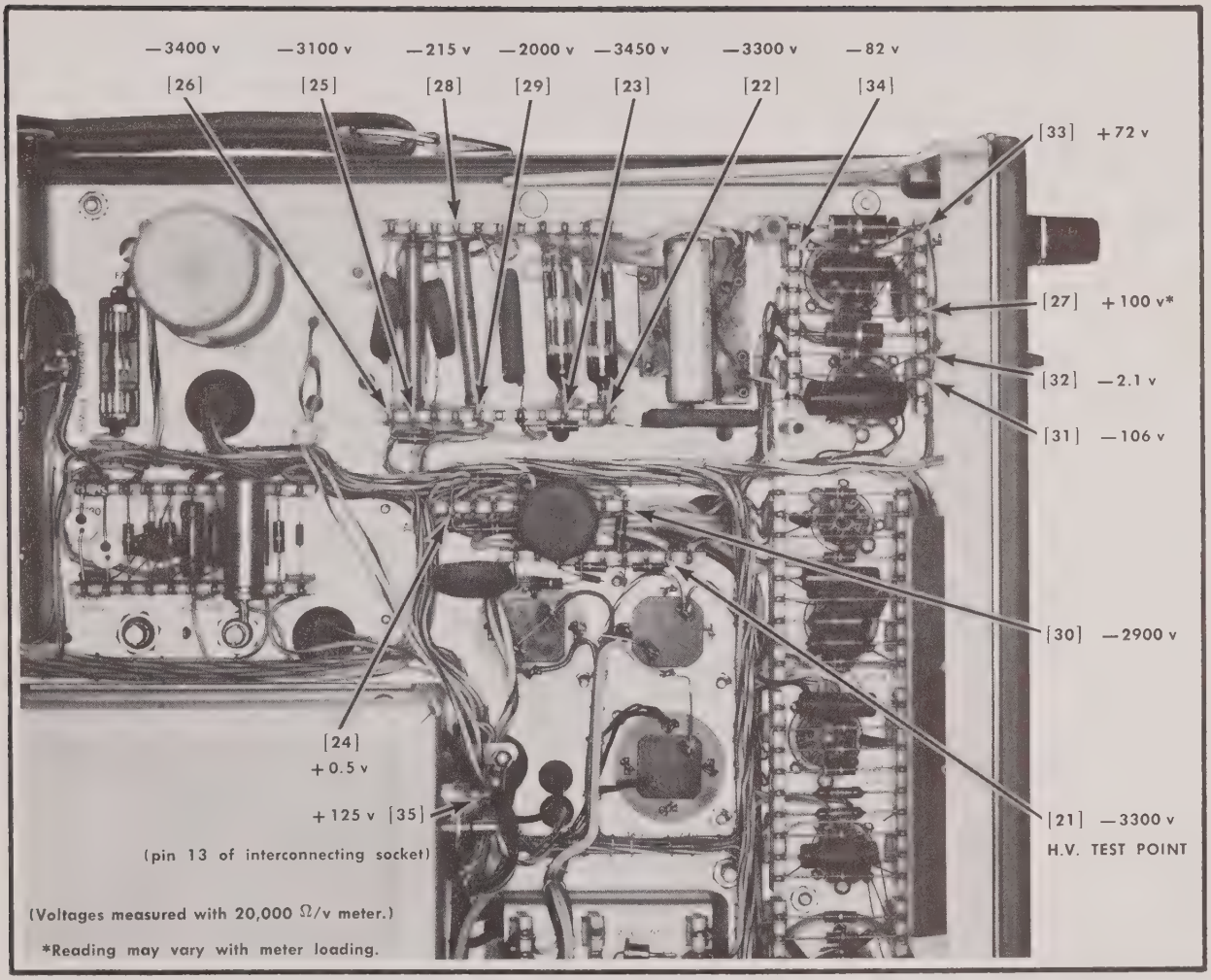


Fig. 4-2. Crt Circuit test points; [21] through [35].

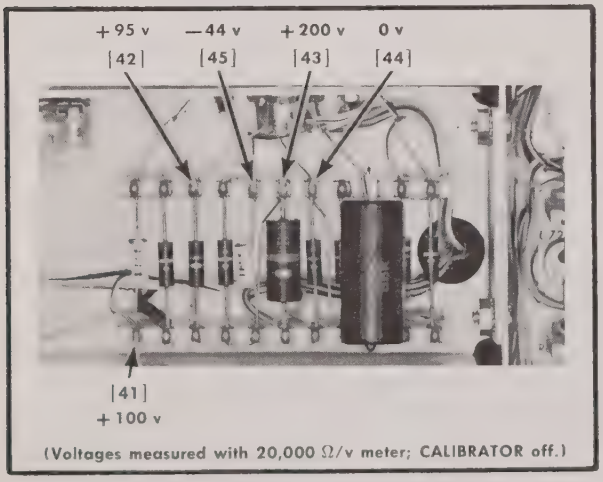


Fig. 4-3. Calibrator test points; [41] through [45].

All signal wiring in the Type 561A is color coded to make circuit tracing easier. In addition, all regulated power supply leads are color coded to follow the standard EIA code. The first color (widest stripe) indicates the first number of the voltage. The second color indicates the second number and the third color (smallest stripe) indicates the multiplier. The voltage is positive if the main color of the wire is white and negative if the main color of the wire is dark. Four colors would be required to indicate all the digits plus a multiplier for the +125-volt leads. To avoid this, the +125-volt leads are coded as +120; that is, brown, red, brown on a white base. A —100-volt lead is coded brown, black, brown on a gray base while +300-volt leads are coded orange, black, brown on white.

The switch wafers shown on the Calibrator diagram are coded to indicate the position of the wafer on the switch. Wafers are numbered from the front of the switch to the rear. The letters F and R indicate whether the front or rear of the wafer is used to perform the particular switching function.

TABLE 4-1

SYMPTOMS	PROBABLE CAUSES	CHECKS TO MAKE
—100-Volt Power Supply		
1. Output voltage slightly higher or lower than normal but regulates with changes in line voltage. (May not regulate over full range of 105 to 125 volts.)	Improper setting of R616. Abnormal voltage across V609. R617 or R618 changed value.	1. Use the —100 V adjustment to try to set the output voltage to normal. 2. Check for regulation with line voltage varied from 105 to 125 volts. Check output ripple voltage. If normal, trouble is corrected. 3. Check for approximately 85 volts across V609 (pin 5 to 7).
2. Output voltage appreciably higher (more negative) than normal. Output voltage does not regulate with changes in line voltage.	Q624 shorted. V609 open. V634B not conducting. V627 shorted. R618, R624 open.	1. Check that V609 is glowing. 2. Check for approximately 85 volts across V609 (pin 5 to 7); if not present, check R612. 3. Check that the heater of V634 is glowing. 4. Check voltage at plate (pin 1) of V634; should be approximately —0.6 volt. Test point [7].
3. Output voltage appreciably lower (less negative) than normal. Output voltage does not regulate with changes in line voltage.	V627 open. V634A not conducting. Low output from rectifier. R619, R617, or R632 open. C616 or C640 shorted.	1. Measure dc voltage across C640A; should be approximately 175 volts. 2. Replace V627 and V634. Output voltage should return to normal. 3. Collector of Q624 should be at about —12 volts.
4. Excessive ripple on output.	C640A, C616, or C640B open.	Check capacitors. Ripple should be 5 mv, peak-to-peak, nominal.
—12.1-Volt Power Supply		
1. Output voltage slightly higher or lower than normal but regulates with changes in line voltage. (May not regulate over full range of 105 to 125 volts.)	—100 V adjustment improperly set. R731 or R732 changed in value.	1. Check output of —100-volt supply. Test point [1]. 2. Check R731 or R732. Use an accurate resistance measuring bridge. 3. Set the output of the —100-volt supply and recheck the output of the —12.2-volt supply. Test point [4].
2. Output voltage appreciably higher (more negative) than normal. Output voltage does not regulate with changes in line voltage.	Q734 or Q744 open. Q757 shorted. R731 open.	1. Check base voltage of Q744; should be +4 to +8 volts. Test point [13]. 2. Check Q734 and R731. If R731 is open, Q734 may be shorted. 3. Short between collector and emitter of Q744. The power supply output voltage should drop.
3. Output voltage appreciably lower (less negative) than normal. Output voltage does not regulate with changes in line voltage.	F720 open. Q757 open. Q734 or Q744 shorted. R732 open. C737 shorted. Low output from rectifiers.	1. Check fuse F720. If open, replace. If fuse blows again, proceed to check 2. 2. Check Q744 for short. If shorted, replace. Replace F720. The fuse should not blow. 3. Check for shorts in power supply output. 4. Check Q757 for short. If shorted, this is cause of F720 blowing. 5. Check voltage across C720A; should be approxiately 18 volts.

(TABLE 4-1 cont'd)

SYMPTOMS	PROBABLE CAUSES	CHECKS TO MAKE
—12.1-Volt Power Supply (continued)		
		6. Check D720 and D721, and C720A and C720B. 7. Check voltage across Q734; should be near 13.5 volts. 8. Check voltage across Q744; should be 0.8 volt or less.
4. Excessive ripple on output.	C720A, C720B, or C757.	Check capacitors.
Other Power Supplies Symptoms and troubleshooting techniques for the +125- and +300-Volt Power Supplies are similar to those described for the —100- and —12.1-Volt Power Supplies.		
CRT Circuit		
1. No high voltage at crt cathode.	Oscillator not operating. V800 defective. T801 defective. V822 defective. C822 shorted. R849 or R852 open.	1. Check heaters of V822 and V832. If heaters are glowing, the oscillator is operating. 2. Check voltage at plate of V822, test point [22]; should be approximately —3.3 kv. 3. Check R849 and R852. 4. Check V822 and C822. If necessary, check secondary winding of T801. 5. Check plate voltage of V800 (pin 9); should be approximately +400 volts. 6. Check C807, R806, R807, and R804. Also check primary winding of T801.
2. No high voltage at crt control grid.	T801 defective. V832 defective. C830, C832, or C836 shorted. R832, R835, R837, or R834 open.	Check voltage at plate of V832, test point [23]; should be approximately —3.4 kv.
3. High voltage outputs do not regulate with change in line voltage, or cannot be set to proper level.	V814 inoperative. R816, R840, R841, R842, R844, R846, R815, or R803 open. C841, C842, or C803 shorted.	1. Check to see if trace or spot on crt can be focused. 2. Check V814, R815, R803 and C841. 3. Check R816, R840, R841, R842, R844, R846 (test points [27], [28], [29], [30], [31]). 4. Check C803 and C842.
4. Spot or trace does not focus properly.	Incorrect outputs from High Voltage Supplies. R844 defective. R864 defective.	1. Check outputs of both High Voltage Supplies. Test points [22] and [23]. 2. Check R844 and R864.
5. Insufficient display brightness.	Defective crt. Low outputs from High Voltage Supplies. R834 or R835 changed value. Crt blanked.	1. Check outputs from High Voltage Supplies. Test points [22] and [23]. 2. Check R834 and R835. 3. Check crt pins 6 and 7 for approximately +125 v.
6. Trace will not align with horizontal graticule markings.	Defective Beam Rotator Coil L860. R860 or R861 defective.	1. Check R860 and R861. Check physical location of Beam Rotator Coil. Change any defective components. It should be possible to align the trace with the graticule markings. 2. Check L860.

(TABLE 4-1 cont'd)

SYMPTOMS	PROBABLE CAUSES	CHECKS TO MAKE
	Calibrator	
1. No output from Calibrator.	V884 defective. Open resistor.	1. Check dc voltage at test point [41]. Voltage will probably be either 0 or +100 volts. If +100 volts, proceed to check 3. If 0 volts, replace V884 and if necessary proceed to check 2. 2. Check plate voltage of V884B, test point [43]; should be approximately +200 volts. 3. Check cathode resistors of V884B. Check for 6.3 vac at the cathode of V884A, test point [44]. 4. Check R883. 5. Check R878 and R879. 6. Check R877 and R876.
2. Incorrect pulse amplitude for all CALIBRATOR switch positions.	Improper setting of R871. Divider resistor in cathode of V884B changed in value.	1. Check setting of CAL. AMPL. control, R871. It should be possible to adjust for correct output. 2. Check resistors in cathode of V884B.

REMOVAL AND REPLACEMENT OF PARTS

Replacement procedures for most parts in the Type 561A are obvious; detailed instructions for their removal are therefore not required. Other parts, however, can best be removed if a definite procedure is followed. Instructions for removing some of these parts are contained in the following paragraphs. Parts-ordering information is included in the Parts List section of this manual.

Whenever a part has been replaced, the calibration of the instrument should be checked and adjusted as necessary.

Cathode-Ray Tube Replacement

To remove the cathode-ray tube, disconnect the four leads connected to the neck of the tube, the tube socket, and loosen the tube clamp. Remove the graticule cover, light reflector, and light shield. Pull the crt straight out through the front panel, being careful not to bend or break the crt neck pins. The rubber gasket and implosion shield can be removed from the crt face after it is out of the instrument.

Install the new crt by the reverse of the preceding procedure. When replacing the implosion shield be sure that the notched side is down. Follow the color-code information on the tube shield when the crt neck pin leads are replaced. When the crt is properly installed, the back of the faceplate is flush with the instrument front panel.

After the crt is replaced, it may be necessary to adjust the ALIGNMENT and HIGH VOLTAGE controls and the deflection plate capacity (C760 and C761). Also give special attention to the calibration of time-base and amplifier plug-in units.

Replacement of Ceramic Terminal Strips

To remove a ceramic terminal strip, unsolder all connections and pry the strip, with yokes attached, out of the chassis (see Fig. 4-4). An alternative method is to use diagonal cutters and cut off one side of each yoke to free the strip, using care not to damage the spacer. After removing the strips, the remainder of each yoke can be easily removed from the chassis with a pair of pliers. The yokes need not be salvaged since new ones are furnished with each strip. However, the spacers may be reused if desired. If new spacers are required, specify the mounting height of the sleeve desired: $^3/_{32}$", $^3/_{16}$", or $^3/_8$". When ordering the ceramic strips specify the number of notches and the correct height.

When the old strip and yokes have been removed, insert the replacement parts into the spacer sleeves that are located in the holes of the chassis. If necessary, use a plastic or hard-rubber mallet to seat the yokes firmly into the spacers.

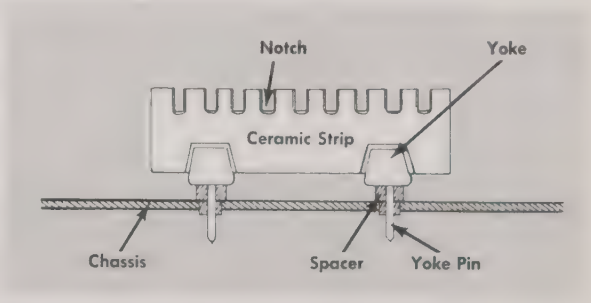


Fig. 4-4. Ceramic terminal strip installation.

Be sure to observe the soldering precautions described in the following paragraph when soldering connections to the new strip.

Soldering Precautions

In the production of Tektronix instruments a special silver-bearing solder is used to establish a bond to the ceramic terminal strips. This bond can be broken by repeated use of ordinary tin-lead solder or by applying too much heat. For this reason, we recommend the use of solder containing about 3% silver and a wedge-shaped soldering-iron tip for installing or removing connections from the strips. The silver-bearing solder is locally available in most areas, or it may be purchased directly from Tektronix in one-pound rolls (order by part number 251-514). Occasional use of ordinary solder will not break the bond unless too much heat is applied.

NOTES

SECTION 5

CALIBRATION

Introduction

This procedure can be used for a complete calibration and operational check of the Type 561A Oscilloscope. By performing each step in the procedure, the Type 561A is completely checked against the performance requirements given in the Characteristics section of the Instruction Manual.

This procedure can be used to verify instrument operation by checking only for the performance requirement listed in each step. If it is desired to merely "touch up" the instrument calibration, perform only those steps entitled "Adjust . . . ◐".

General Information

For the quickest and most accurate calibration, specialized calibration equipment is used where applicable. If this equipment is not available or if equipment is substituted, the characteristics of the equipment used must equal or exceed the requirements listed under "Equipment Required". If the test equipment does not meet these requirements, the Type 561A cannot be calibrated to the accuracy given.

Any needed maintenance should be performed before proceeding with calibration. Troubles which become apparent during calibration should be corrected using the technique given in Section 4 of the Instruction Manual.

When calibrating a complete 561A system (indicator unit and plug-ins), always calibrate the Type 561A Oscilloscope first. The plug-in units need not be calibrated, but must be working properly.

This procedure is arranged in a sequence which allows this instrument to be calibrated with the least interaction of adjustments and reconnection of equipment. If desired, the steps may be performed out of sequence or a step may be performed individually. Each step contains complete information for performing that step. However, some adjustments affect the calibration of other circuits within the instrument. In this case, it will be necessary to check the operation of other parts of the instrument. When there is interaction, the calibration steps which need to be checked are noted at the end of the step.

The location of test points and adjustments is shown in each step. Waveforms which are helpful in determining the correct adjustment or operation are also shown.

Where references are made to divisions of deflection, the indication will be major divisions.

Equipment Required

The following equipment is required for complete calibration of the Type 561A (Figs. 5-1 and 5-2). Specifications given are the minimum necessary to calibrate the Type 561A to the listed requirements.

1. Tektronix 2- or 3-series amplifier plug-in unit.[1]

2. Tektronix 2- or 3-series time-base plug-in unit.[1]

3. Dc voltmeter. Minimum sensitivity, 20,000 ohms/volt; accuracy, checked to 1% at —100 volts, —12.2 volts, +125 volts and +300 volts and ±3% at —3000 volts. For example, Simpson Model 262.[2]

4. Variable autotransformer. Must be capable of supplying at least 350 volt-amperes over a voltage range of 105 to 125 volts (210 to 250 volts for 234-volt nominal line). For example, General Radio W10MT3W Metered Variac Autotransformer.

5. Test oscilloscope. Frequency response, 10 Mc; minimum deflection factor, 0.005 volts/division. Tektronix Type 530-, 540-series oscilloscope with Type B plug-in unit or Tektronix Type 561A with Type 3A1 and 2A63 amplifier plug-ins and Type 3B4 time-base plug-in recommended.

6. CRT deflection capacitance normalizer. Tektronix Calibration Fixture, 067-0500-00, recommended.[4]

7. Standard amplitude calibrator. Amplitude accuracy, 0.25%; signal amplitude, 0.2 millivolts to 100 volts; output signals, 1-kc square wave and +dc. Tektronix Calibration Fixture, 067-0502-00, recommended.

8. Termination. Impedance, 50-ohm; connectors, BNC; accuracy, ±0.1%. Tektronix Calibration Fixture, 067-0515-00.

9. 1× probe. BNC Connector. Tektronix P6028 Probe, Tektronix Part No. 010-0120-00.

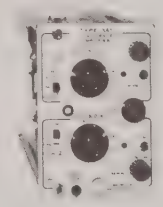
10. Cable (three). Impedance, 50-ohm; connectors, BNC. Tektronix Part No. 012-0057-00.

[1] **Use maximum performance plug-in units. For example, use a high-frequency unit in preference to low-frequency, dual-trace rather than single-trace, etc.**

[2] **When used with sampling plug-in units, the Type 561A low-voltage power supplies must be adjusted to 0.5% or better for correct plug-in operation. Use a dc voltmeter with accuracy better than 0.05%.**

[3] **Used only to check power-supply regulation and ripple in steps 6, 7 and 8. May be deleted from list if these checks are not performed.**

[4] **Normally required only if new cathode-ray tube has been installed or if deflection-plate compensation has been inadvertently misadjusted. An alternative method of adjustment is also given in step 16B.**

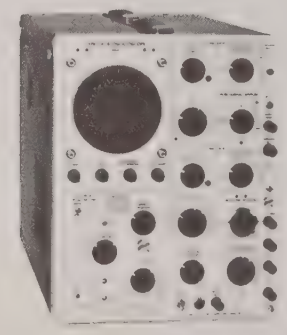


(1)

(2)

(3)

(4)



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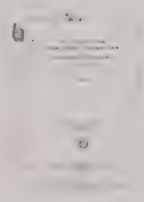

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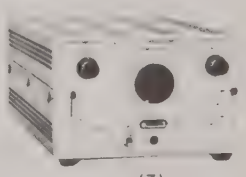


(7)

Fig. 5-1. Recommended calibration equipment, items 1 through 7.

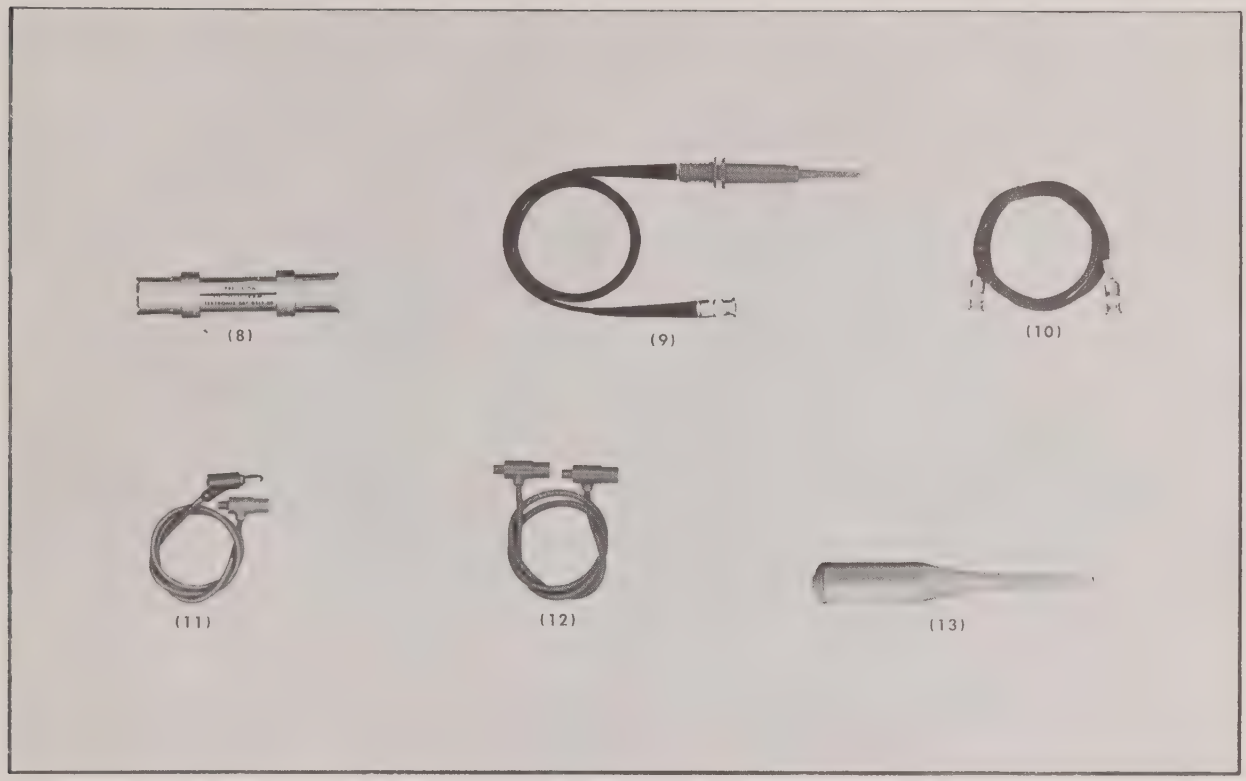


Fig. 5-2. Recommended calibration equipment, items 8 through 13.

11. Patch cord. Length, 18"; connectors, BNC-to-banana plug. Tektronix Part No. 012-0091-00.

12. Patch cord. Length, 18", connectors, BNC-to-BNC. Tektronix Part No. 012-0087-00.

13. Adjustment tool. Insulated screwdriver, non-metallic. Tektronix Part No. 003-0000-00.

14. Jumper lead (not shown). Length, 6"; connectors, insulated alligator clips. Not available from Tektronix.

ABRIDGED CALIBRATION PROCEDURE AND INDEX

This Abridged Calibration Procedure is provided to aid in checking the operation of the Type 561A. It may also be used as a guide to calibration. The step numbers and titles used here are the same as used in the Calibration Procedure.

Type 561A, Serial No. _____

Calibration Date _____

☐ 1. Adjust —100-Volt Power Supply (Page 5-5)
—100 volts, ±3 volts.

☐ 2. Adjust +125-Volt Power Supply (Page 5-5)
+125 volts, ±3.8 volts.

☐ 3. Adjust +300-Volt Power Supply (Page 5-5)
+300 volts, ±9 volts.

☐ 4. Adjust —12.2-Volt Power Supply (Page 5-6)
—12.2 volts, ±0.37 volts.

☐ 5. Adjust High-Voltage Power Supply (Page 5-6)
—3300 volts, ±100 volts.

☐ 6. Check Low-Voltage Power-Supply Regulation (Page 5-6)

—100 volt	1 volt
+125 volt	1.25 volts
+300 volt	3 volts
—12.2 volt	0.12 volt

Check regulation at low and high line.

☐ 7. Check High-Voltage Power-Supply Regulation (Page 5-7)
Within ±100 volts at low and high line.

☐ 8. Adjust Calibrator Amplitude (Page 5-8)
+100 volts, ±3 volts.

☐ 9. Check D838-D839 Junction Voltage (Page 5-8)
Less than +0.6 volts dc.

☐ 10. Check Power-Supply Ripple (Page 5-9)

—100 volt	5 millivolts
+125 volt	10 millivolts
+300 volt	80 millivolts
—12.2 volt	3 millivolts
—3300 volt	DO NOT MEASURE

☐ 11. Adjust Astigmatism (Page 5-9)
Sharp, well-defined display.

☐ 12. Adjust Trace Alignment (Page 5-9)
Trace parallel to horizontal graticule lines.

☐ 13. Adjust Cathode-Ray Tube Geometry (Page 5-10)
Best overall geometry.

☐ 14. Check Calibrator Accuracy (Page 5-11)
Within ±3% of indicated voltage.

☐ 15. Check Calibrator Risetime and Symmetry (Page 5-13)
Risetime, less than 6 microseconds; Symmetry, 40% to 60%.

☐ 16. Adjust Vertical and Horizontal Deflection-Plate Compensation (Page 5-14)
Optimum square corner (or 14.3 picofarads effective capacitance).

☐ 17. Check Dual-Trace Chopped Blanking (Page 5-16)
Blanking of between channel switching transients (with dual-trace amplifier unit).

☐ 18. Check Crt Intensifier Circuit (Page 5-16)
Intensified portion on trace (with delayed sweep time-base unit).

☐ 19. Check Crt Vertical Sensitivity (Page 5-18)
19.5 volts, ±1 volt.

☐ 20. Check Crt Horizontal Sensitivity (Page 5-18)
18.4 volts, ±0.9 volt.

☐ 21. Check Intensity (Z-Axis) Modulation (Page 5-19)
Intensity modulation with 5 volts input.

CALIBRATION PROCEDURE

General

In the following calibration procedure, a test equipment setup is shown for each major setup change. Complete control settings are listed beneath the picture. To aid in locating individual controls which have been changed during complete calibration, these control names are printed in bold type. If only a partial calibration is performed, start with the nearest setup preceding the desired portion.

NOTE

When performing a complete recalibration, best performance will be provided if each adjustment is made to the exact setting, even if the Check is within the allowable tolerance.

The following procedure uses the equipment listed under 'Equipment Required'. If substitute equipment is used, control settings or setup must be altered to meet the requirements of the equipment used.

Preliminary Procedure

1. Remove both side panels from the Type 561A.

2. Insert the amplifier plug-in unit in the left plug-in compartment.

3. Insert the time-base plug-in unit in the right plug-in compartment.

4. Connect the autotransformer (if used) to a suitable power source.

5. Connect the power cord to the autotransformer output (or directly to power source).

6. Set the autotransformer output voltage for the nominal operating voltage of the instrument.

7. Turn the POWER switch ON. Allow about 20 minutes warm up before making any adjustments.

NOTES

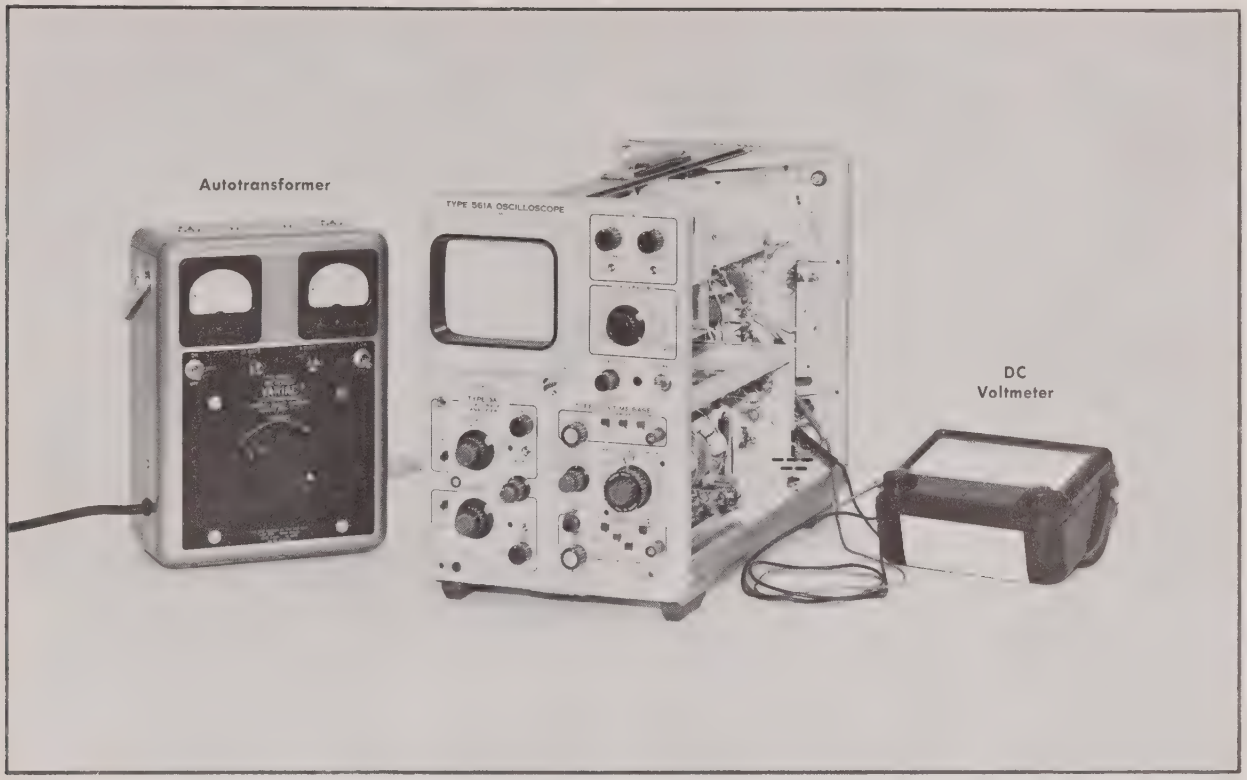


Fig. 5-3. Test equipment setup for power-supply adjustments.

Type 561A controls

FOCUS	Any position
INTENSITY	Midrange
CALIBRATOR	OFF
SCALE ILLUM	Any position
POWER	ON
CRT CATHODE SELECTOR	Up

Amplifier unit controls

Position	Midrange
Ac Dc Gnd	Ac
Volts/Division	1
Variable	Calibrated

Time-base unit controls

Position	Midrange
Magnifier	Off
Time/Division	1 millisecond
Variable	Calibrated
Triggering controls	Any position

1. Adjust —100-Volt Power Supply

a. Test equipment setup is shown in Fig. 5-3.

b. Connect the dc voltmeter from the —100-volt test point (Fig. 5-4a) to chassis ground.

c. **Check**—Meter reading; —100 volts, ±3 volts.

d. **Adjust**— —100 V adjustment, R616 (Fig. 5-4b) for —100 volts.

e. **Interaction**—May affect operation of all circuits within the Type 561A.

2. Adjust +125-Volt Power Supply

a. Test equipment setup is shown in Fig. 5-3.

b. Connect the dc voltmeter from the +125-volt test point (Fig. 5-4a) to chassis ground.

c. **Check**—Meter reading; +125 volts, ±3.8 volts.

d. **Adjust**— +125 Volts adjustment, R656 (Fig. 5-5), for +125 volts.

e. **Interaction**—May affect operation of all circuits within the Type 561A.

Below S/N 6635. No adjustment provided. Perform only steps a through c.

3. Adjust +300-Volt Power Supply

a. Test equipment setup is shown in Fig. 5-3.

b. Connect the dc voltmeter from the +300-volt test point (Fig. 5-4a) to chassis ground.

c. **Check**—Meter reading; +300 volts, ±9 volts.

d. **Adjust**— +300 Volts adjustment, R676 (Fig. 5-5), for +300 volts.

e. **Interaction**—May affect operation of all circuits within the Type 561A.

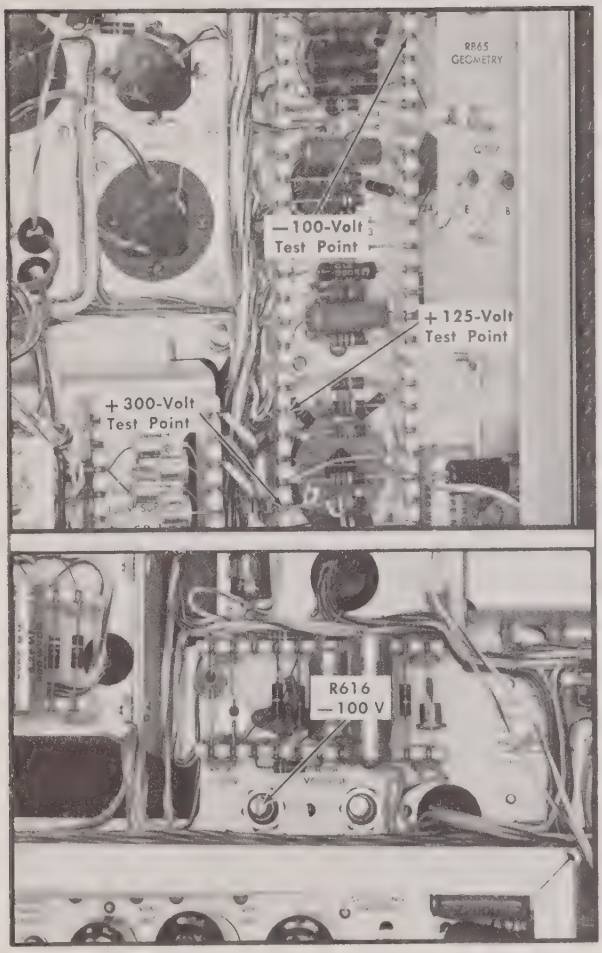


Fig. 5-4. (a) Location of —100-, +125- and +300-volt test points (right side); (b) location of —100-volt adjustment (right side).

Below S/N 6635. No adjustment provided. Perform only steps a through c.

4. Adjust —12.2-Volt Power Supply

a. Test equipment setup is shown in Fig. 5-3.

b. Connect the dc voltmeter from the —12.2-volt test point (Fig. 5-6) to chassis ground.

c. **Check**—Meter reading; —12.2 volts, ±0.37 volts.

d. **Adjust**— —12.2-Volts adjustment, R730 (Fig. 5-5), for —12.2 volts.

e. **Interaction**—May affect operation of all circuits within the Type 561A.

Below S/N 6635. No adjustment provided. Perform only steps a through c.

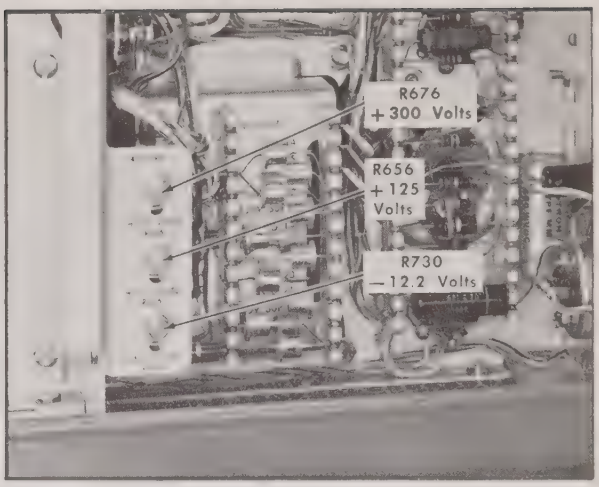


Fig. 5-5. Location of +125-, +300- and —12.2-volt adjustments (right side).

5. Adjust High-Voltage Power Supply

a. Test equipment setup is shown in Fig. 5-3.

b. Connect the dc voltmeter from the high-voltage test point (Fig. 5-7a) to chassis ground.

c. **Check**—Meter reading; —3300 volts, ±100 volts.

d. **Adjust**—High Voltage adjustment, R841 (Fig. 5-7b), for —3300 volts.

e. **Interaction**—Check steps 7, 11-13 and 16.

6. Check Low-Voltage Power-Supply Regulation

a. Test equipment setup is shown in Fig. 5-3.

b. Connect the dc voltmeter from the —100-volt test point (Fig. 5-4a) to chassis ground.

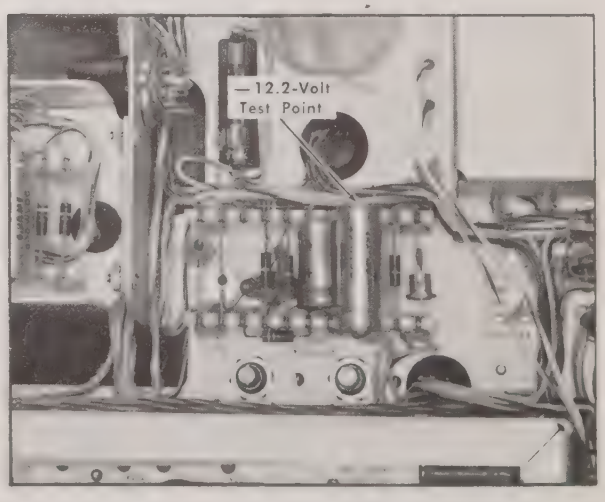


Fig. 5-6. Location of —12.2-volt test point (right side).

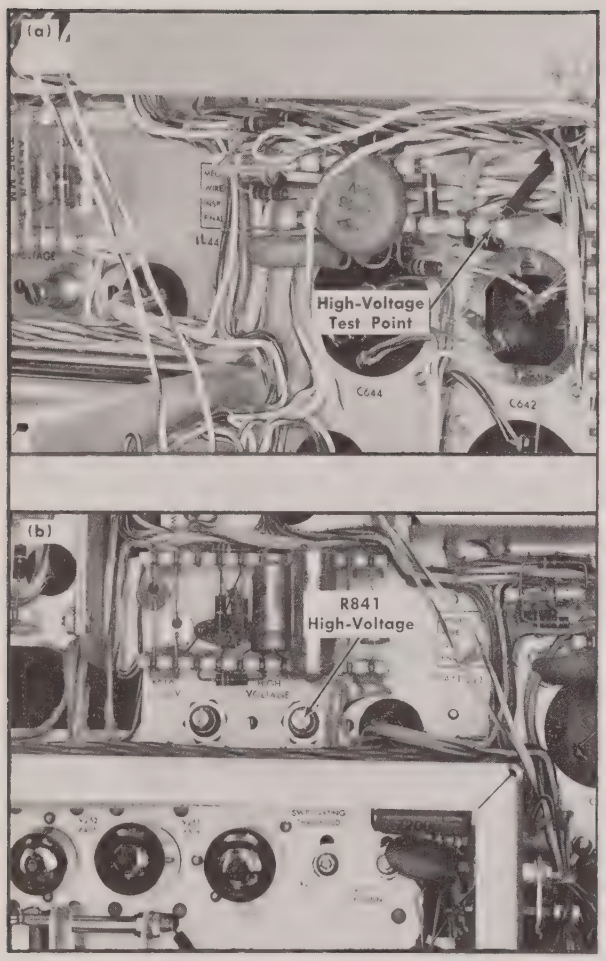


Fig. 5-7. (a) Location of high-voltage test point (right side); (b) location of high-voltage adjustment (right side).

c. With the autotransformer set to 117 volts (or 234 volts) note the test point voltage.

d. Set the autotransformer to 105 (210) volts and again check the voltage. Voltage should be within 1 volt of reading in step c.

e. Set the autotransformer to 125 (250) volts and check the voltage. Voltage should be within 1 volt of reading in step c.

f. Remove both plug-ins from the instrument (minimum load).

g. With the autotransformer set to 125 (250) volts, the voltage should be within 1 volt of reading in step c.

h. Return the autotransformer to 105 (210) volts and check the voltage. Voltage should be within 1 volt of reading in step c.

i. Repeat this procedure for each low-voltage supply. Table 5-1 shows maximum voltage deviation allowable for each supply. Test point locations are shown in Figs. 5-4a and 5-6.

NOTE

A 150-milliamp minimum load current is necessary for proper regulation of the —12.2-volt supply. Minimum-load regulation of this supply can be checked by placing an 82-ohm, 5-watt resistor between pins 5 and 16 of either interconnecting plug.

TABLE 5-1

Power Supply	Maximum Voltage Deviation
—100 volt	1 volt
+125 volt	1.25 volts
+300 volt	3 volts
—12.2 volt	0.12 volt

7. Check High-Voltage Power-Supply Regulation

a. Test equipment setup is shown in Fig. 5-3.

b. Connect the dc voltmeter from the high-voltage test point (Fig. 5-7a) to chassis ground.

c. Set the autotransformer to 117 (234) volts and note the voltage at the test point.

d. Set the autotransformer to 105 (210) volts and check the voltage. It should be within 100 volts of reading in step c.

e. Set the autotransformer to 125 (250) volts and check the voltage. Voltage should be within 100 volts of reading in step c.

f. Return the autotransformer to 117 (234) volts and disconnect the voltmeter.

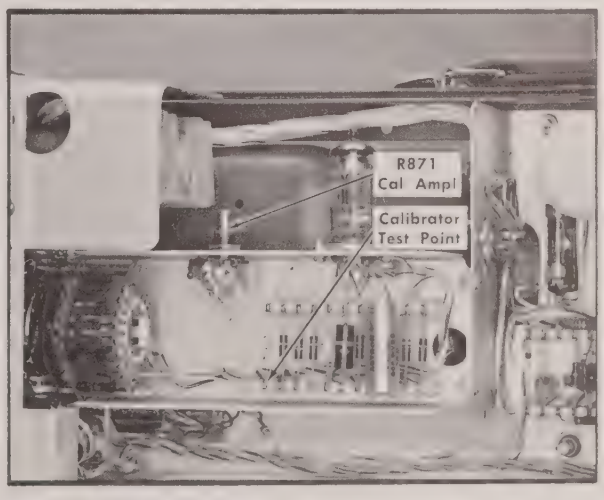


Fig. 5-8. Location of calibrator test point and adjustment (right side).

8. Adjust Calibrator Amplitude

a. Test equipment setup is shown in Fig. 5-3.

b. Connect the dc voltmeter from the calibrator test point (Fig. 5-8) to chassis ground.

c. **Check**—Meter reading; +100 volts, ±3 volts. Be sure the CALIBRATOR switch is set to OFF.

d. **Adjust**—Cal Ampl adjustment, R871 (Fig. 5-8), for +100 volts.

9. Check D838-D839 Junction Voltage

a. Connect the voltmeter from the D838-D839 test point (Fig. 5-9) to chassis ground.

b. Voltage should be less than +0.6 volts dc. Higher voltages could damage a time-base unit with an intensifying circuit.

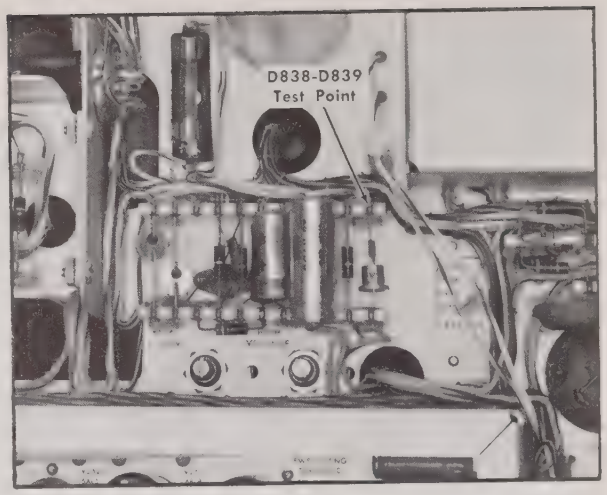


Fig. 5-9. Location of D838-D839 test point (right side).

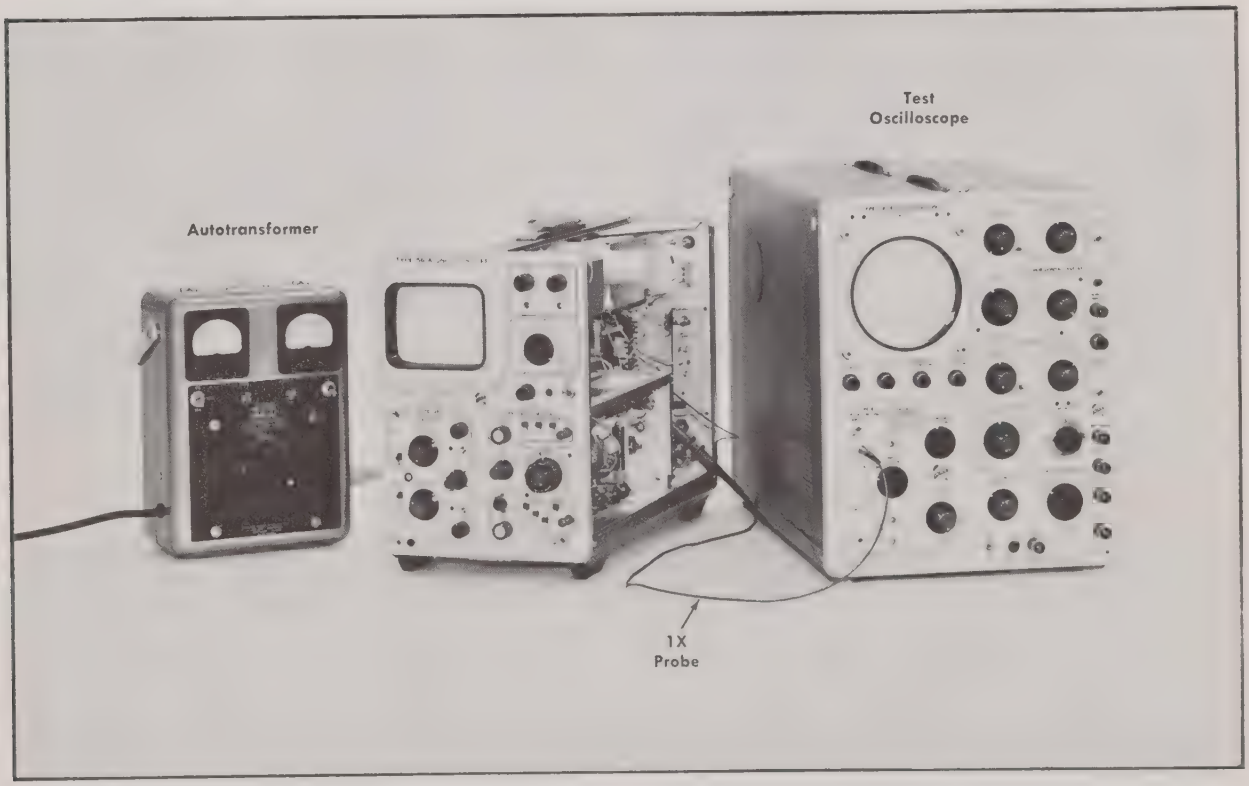


Fig. 5-10. Test equipment setup for power-supply ripple measurements.

Type 561A controls	
FOCUS	Any position
INTENSITY	Midrange
CALIBRATOR	OFF
SCALE ILLUM	Any position
POWER	ON
CRT CATHODE SELECTOR	Up
Amplifier unit controls	
Position	Midrange
Ac Dc Gnd	Ac

Volts/Division	1
Variable	Calibrated
Time-base unit controls	
Position	Midrange
Magnifier	Off
Time/Division	1 millisecond
Variable	Calibrated
Triggering controls	**Adjust so sweep is not triggered**

10. Check Power-Supply Ripple

a. Test equipment setup is shown in Fig. 5-10.

b. Connect the 1× probe to the test oscilloscope input.

c. Set the test oscilloscope Volts/Division switch to 0.005. Set the input coupling switch to ac.

d. Measure the line-frequency ripple of each regulated power supply at the power-supply test points. Test points are shown in Figs. 5-4a and 5-6. Table 5-2 gives maximum ripple for each supply. Check ripple with autotransformer set at 105, 117 and 125 (210, 234 and 250 if wired for 234-volts nominal). Fig. 5-11 shows typical test oscilloscope display.

e. Disconnect the test oscilloscope and return the autotransformer to line voltage (instrument may be connected directly to line).

TABLE 5-2

Power Supply	Maximum Ripple (millivolts)
—100 volt	5
+125 volt	10
+300 volt	80
—12.2 volt	3
—3300 volt	DO NOT MEASURE

11. Adjust Astigmatism

a. Connect the CAL OUT connector to the amplifier unit input connector with a BNC cable.

b. Set the CALIBRATOR switch to 2 VOLTS.

c. Set the time-base unit triggering controls to produce a trace on the crt.

d. Adjust the FOCUS control and ASTIGMATISM adjustment, R864 (Fig. 5-12) for a sharp, well-defined display over the entire trace length.

e. Slight readjustment of these controls may be necessary during normal operation.

f. Disconnect the cable.

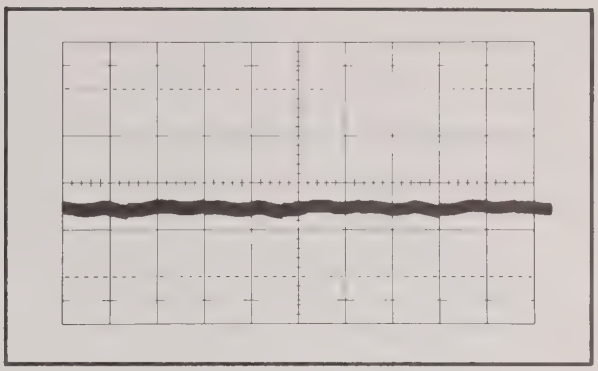


Fig. 5-11. Typical test oscilloscope display showing power-supply ripple (—100-volt supply). Volts/division, 0.005 volts, ac coupled; time/division, 5 milliseconds.

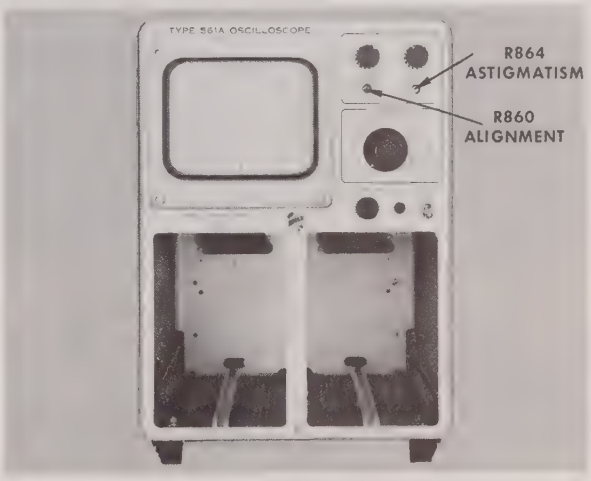


Fig. 5-12. Location of ASTIGMATISM and ALIGNMENT adjustments (front panel).

12. Adjust Trace Alignment

a. Adjust the amplifier unit Position control to move the trace to the horizontal graticule centerline.

b. **Check**—The trace should be parallel with the centerline.

c. **Adjust**—ALIGNMENT adjustment, R860 (Fig. 5-12), so the trace is parallel with the horizontal graticule lines.

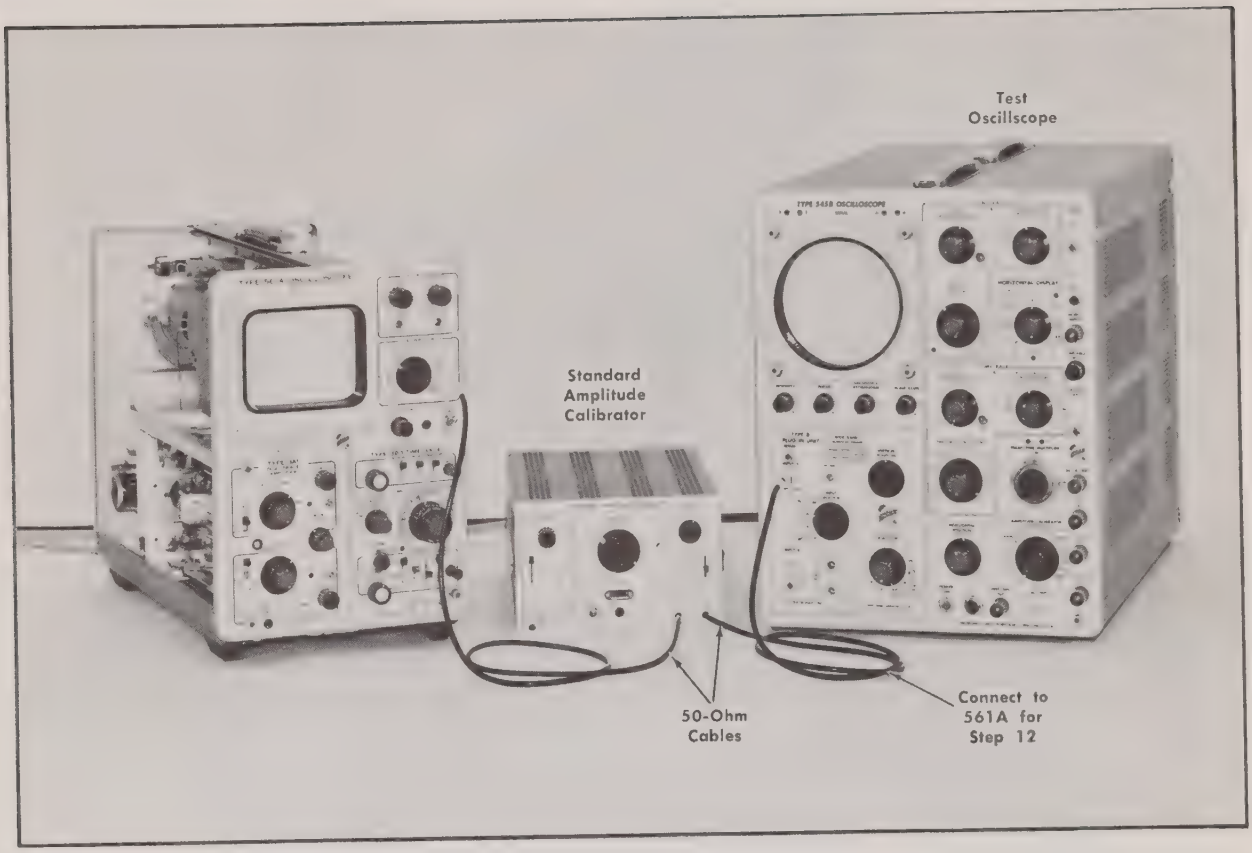


Fig. 5-13. Test equipment setup for geometry adjustment and CALIBRATOR check.

Type 561A controls	
FOCUS	Adjust for focused display
INTENSITY	Midrange
CALIBRATOR	**100**
SCALE ILLUM	Any position
POWER	ON
CRT CATHODE SELECTOR	Up
Amplifier unit controls	
Position	Midrange
Ac Dc Gnd	Ac
Volts/Division	1
Variable	Calibrated
Time-base unit controls	
Position	Midrange
Magnifier	Off
Time/Division	1 millisecond
Variable	Calibrated
Triggering Controls	**Automatic**

13. Adjust Cathode-Ray Tube Geometry

a. Test equipment setup is shown in Fig. 5-13.

b. Set the Standard Amplitude Calibrator controls as follows (if the test oscilloscope has a 1-Kc Calibrator, it may be used for this step):

Amplitude	10 Volts
Mode	Square wave
Function	Up
Power	On

c. Connect the Standard Amplitude Calibrator Output connector to the amplifier unit input connector.

d. Adjust the time-base unit Position and Variable Time/Division controls so a rising portion of the waveform coincides with the left and right graticule lines. The INTENSITY control may need to be advanced slightly to view the rising portions of the waveform (top and bottom of square wave should be positioned off of the viewing area).

e. **Check**—Good linearity at the left and right edges of the graticule (Fig. 5-14a shows typical crt display as well as examples of poor geometry).

f. **Adjust**—Geometry adjustment, R865 (Fig. 5-14b), for best linearity at left and right edges of the graticule. If

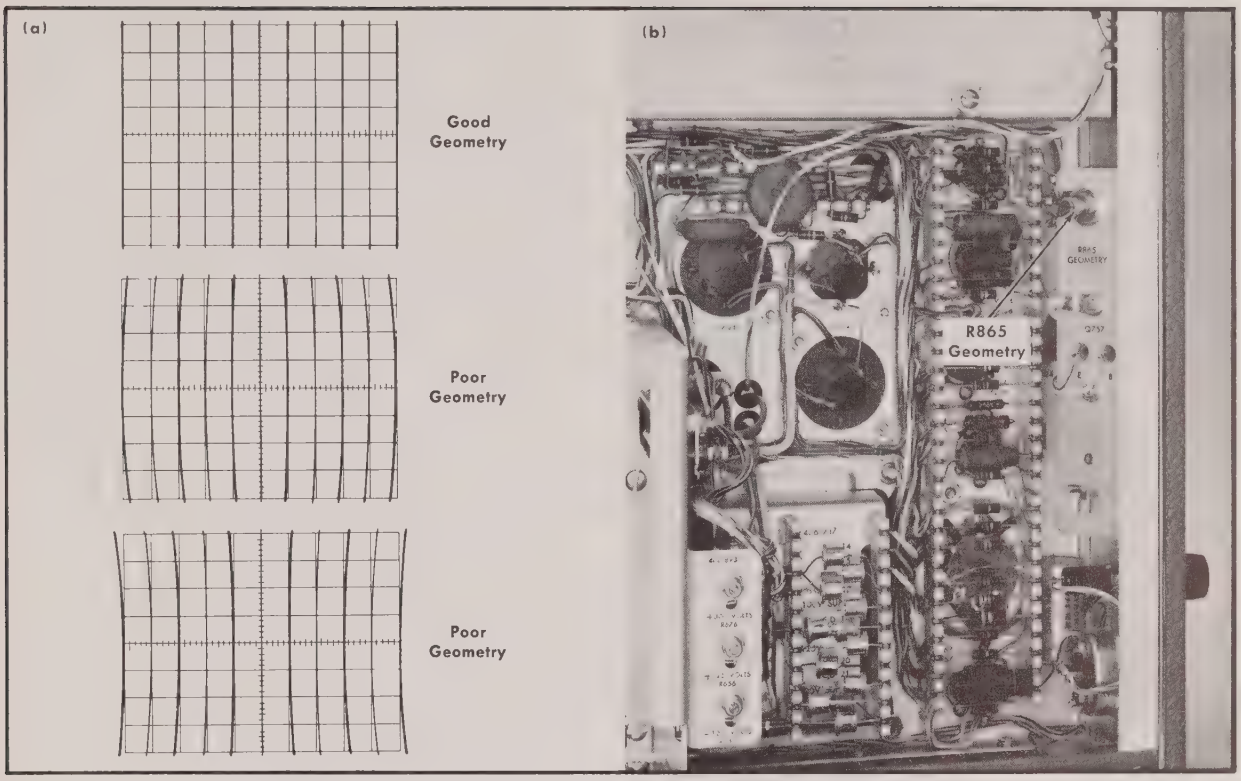


Fig. 5-14. (a) Idealized waveforms showing good geometry with examples of poor geometry; (b) location of geometry adjustment (right side).

a setting cannot be found that provides best linearity on both sides of the graticule, a compromise setting will be necessary to provide best overall linearity.

g. Disconnect the signal from the amplifier unit input and return the INTENSITY control to normal setting.

14. Check Calibrator Accuracy

a. Test equipment setup is shown in Fig. 5-13.

b. Change the following Standard Amplitude Calibrator controls:

Amplitude	100 Volts
Mode	+DC
Function	Mixed
Ac Dc Gnd	Dc

c. Connect the CAL OUT connector to the Standard Amplitude Calibrator Unknown Input with a 50-ohm cable.

d. Connect the Standard Amplitude Calibrator Output connector to the test oscilloscope input (minimum deflection factor, 0.005 volts/division) with a 50-ohm cable.

e. Connect the 6" jumper lead from pin 8, V884 (Fig. 5-15a), to chassis ground. This provides a dc calibrator output voltage.

f. The difference between the Standard Amplitude Calibrator +DC voltage and the Type 561A CALIBRATOR output voltage should be less than 3%. Table 5-3 gives maximum allowable difference for 3% CALIBRATOR accuracy at each position of the CALIBRATOR switch. (The Standard Amplitude Calibrator output can be identified by setting the Type 561A CALIBRATOR switch to a higher or lower position; the signal which remains is the Standard Amplitude Calibrator output.) Fig 5-15b shows a typical test oscilloscope display. Check accuracy of all positions between 100 and .1 VOLTS.

g. Set the CALIBRATOR switch to the .1 V INTO 50 Ω position (.5 VOLTS position).

h. Connect the 50-ohm termination (067-0515-00) between the CAL OUT connector and the 50-ohm cable.

i. Leave the Standard Amplitude Calibrator Amplitude switch set to .1 Volts and set the test oscilloscope Volts/Division switch to 0.005.

j. The test oscilloscope display should be 0.6 division or less in amplitude for 3% accuracy.

k. Remove the 50-ohm termination and reconnect the 50-ohm cable to the CAL OUT connector.

l. Connect the Standard Amplitude Calibrator Output connector to the ×100 Amplifier Input connector with a 50-ohm cable.

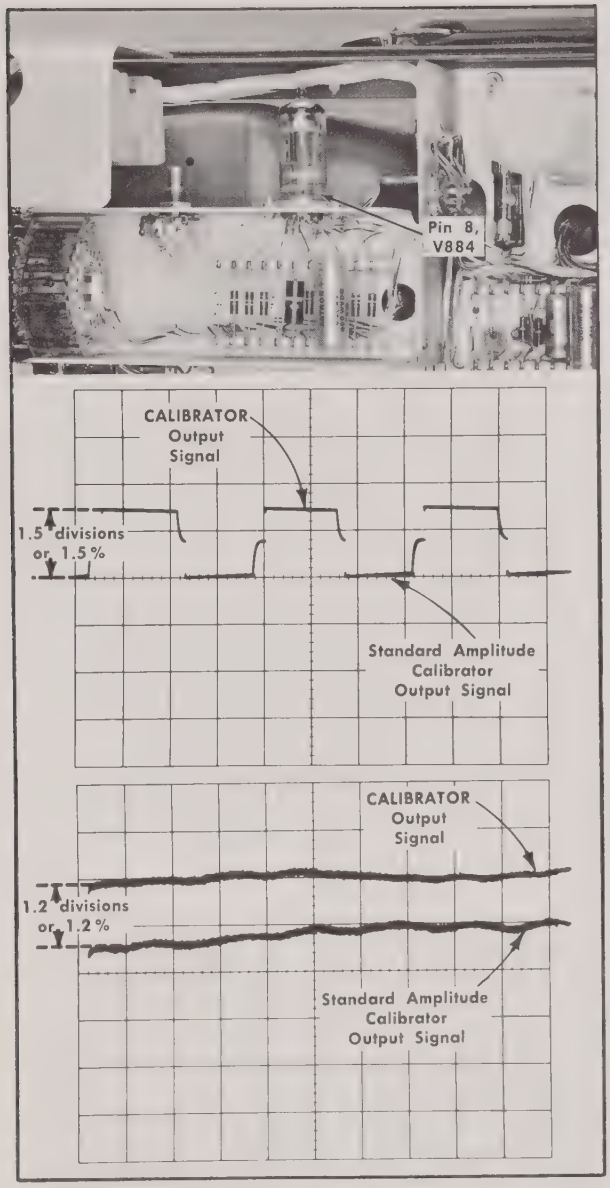


Fig. 5-15. (a) Location of pin 8, V884 (right side); (b) typical test oscilloscope display showing about +1.5% error in the 10 VOLTS position (volts/division, 0.1 volts; time/division, 5 milliseconds); (c) typical test oscilloscope display showing about +1.2% error in the 10 mVOLTS position (volts/division, 20 millivolts; time/division, 0.2 milliseconds; using X100 Amplifier section).

m. Connect the Output ±50 V Max connector to the input of the test oscilloscope.

n. Set the test oscilloscope Time/Division switch to 0.2 milliseconds. Adjust the Standard Amplitude Calibrator Output Dc Level control to center the trace on the screen.

o. Check the accuracy of all CALIBRATOR switch positions between 50 mVOLTS and .2 mVOLTS. Table 5-3 gives maximum allowable difference and control settings. Fig. 5-15c shows a typical test oscilloscope display.

TABLE 5-3

Type 561A CALIBRATOR setting and Standard Amplitude Calibrator setting	Test Oscilloscope Volts/Division Switch Setting	Maximum Display Amplitude for 3% Accuracy (divisions)
100 VOLTS	1 Volt	3*
50 VOLTS	.5 Volt	3
20 VOLTS	.2 Volt	3
10 VOLTS	.1 Volt	3
5 VOLTS	50 Millivolts	3
2 VOLTS	20 Millivolts	3
1 VOLTS	10 Millivolts	3
.5 VOLTS	5 Millivolts	3
.2 VOLTS	5 Millivolts	1.2
.1 VOLTS	5 Millivolts	0.6
50 mVOLTS	50 Millivolts	3
20 mVOLTS	20 Millivolts	3
10 mVOLTS	10 Millivolts	3
5 mVOLTS	5 Millivolts	3
2 mVOLTS	5 Millivolts	1.2
1 mVOLTS	5 Millivolts	.6
.5 mVOLTS	5 Millivolts	.3
.2 mVOLTS	5 Millivolts	.12

***For maximum Calibrator accuracy, reset the Cal Ampl adjustment for minimum difference.**

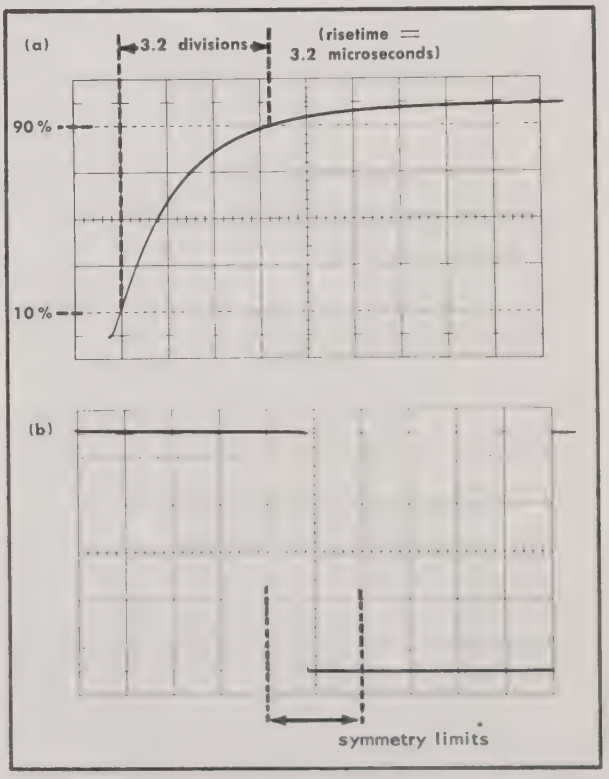


Fig. 5-16. (a) Typical test oscilloscope display for checking Calibrator risetime (time/division, 1 microsecond); (b) typical test oscilloscope display for checking Calibrator symmetry.

p. Disconnect all test equipment and remove the jumper lead from pin 8 of V884.

15. Check Calibrator Risetime and Symmetry

a. Test equipment setup is shown in Fig. 5-13.

b. Connect the CAL OUT connector to the vertical input of the test oscilloscope with a 50-ohm cable.

c. Set the CALIBRATOR switch to 1 VOLTS.

d. Set the test oscilloscope Time/Division switch to 1 microsecond and the Volts/Division and Variable control for exactly 5 divisions of display (four divisions if using 540A-series test oscilloscope).

e. Check for risetime of less than 6 microseconds as shown by less than 5 divisions between the 10% and 90% points on the test oscilloscope display (see Fig. 5-16a).

f. Set the test oscilloscope Time/Division switch and Variable controls to display one complete cycle of the Calibrator signal in 10 divisions. Adjust the triggering controls if necessary, so the display starts on the leading edge of the waveform.

g. Check for Calibrator symmetry of ±20%. This is shown by each segment of the square wave having a length of 4 and 6 divisions (see Fig. 5-16b).

h. Disconnect the test oscilloscope.

NOTES

Fig. 5-17. Test equipment setup for vertical and horizontal compensation.

Type 561A controls	
FOCUS	Adjust for focused display
INTENSITY	Midrange
CALIBRATOR	**100**
SCALE ILLUM	Any position
POWER	ON
CRT CATHODE SELECTOR	Up
Amplifier unit controls	
Position	Midrange
Ac Dc Gnd	Ac
Volts/Division	1
Variable	Calibrated
Time-base unit controls	
Position	Midrange
Magnifier (5×)	On
Time/Division	**1 millisecond**
Variable	Calibrated
Triggering Controls	**Adjust for triggered on negative slope**

16A. Adjust Vertical and Horizontal Deflection-Plate Compensation

a. Test equipment setup is shown in Fig. 5-17.

b. Insert the CRT Deflection Capacitance Normalizer into the left plug-in compartment.

c. Connect the CAL OUT connector to the Capacitance Normalizer input connector.

d. Adjust the time-base triggering controls and the horizontal position control so the leading edge of the waveform is displayed as in Fig. 5-18.

NOTE

The INTENSITY control may need to be advanced slightly to view the leading edge of the waveform.

e. **Check**—For optimum square corner (see Fig. 5-18a).

f. **Adjust**—C760 (Fig. 5-18d) for optimum square corner.

g. Interchange the Capacitance Normalizer and the time-base unit. Readjust the FOCUS control and the time-base triggering controls for a stable well-focused display.

h. **Check**—For optimum square corner (see Fig. 5-19a).

i. **Adjust**—C761 (Fig. 5-19b) for optimum square corner.

j. Remove the Capacitance Normalizer. Replace the amplifier unit in the left compartment and the time-base unit in the right compartment.

16B. Alternative Method of adjusting deflection plate compensation.

NOTE

The following method can be used to adjust the deflection-plate compensation if a Capacitance Normalizer is not available.

The effective deflection-plate capacitance of the crt is the capacitance seen by the plug-in unit when the deflection plates are driven push-pull. Therefore, it cannot be measured directly with a capacitance meter. However, the individual circuit capacitances which make up the effective deflection-plate capacitance can be measured. These individual circuit capacitances are shown schematically in Fig. 5-20. C1 and C2 represent the capacitance from each deflection plate to ground. C3 represents the capacitance between the deflection plates. The variable capacitor is made up of the circuit capacitance plus the capacitor added for adjustment.

The variable capacitor for the vertical (left) plug-in compartment may be C3 (Fig. 5-20a) or C2 (Fig. 5-20b) depending on other circuit capacitance values. Check the instrument

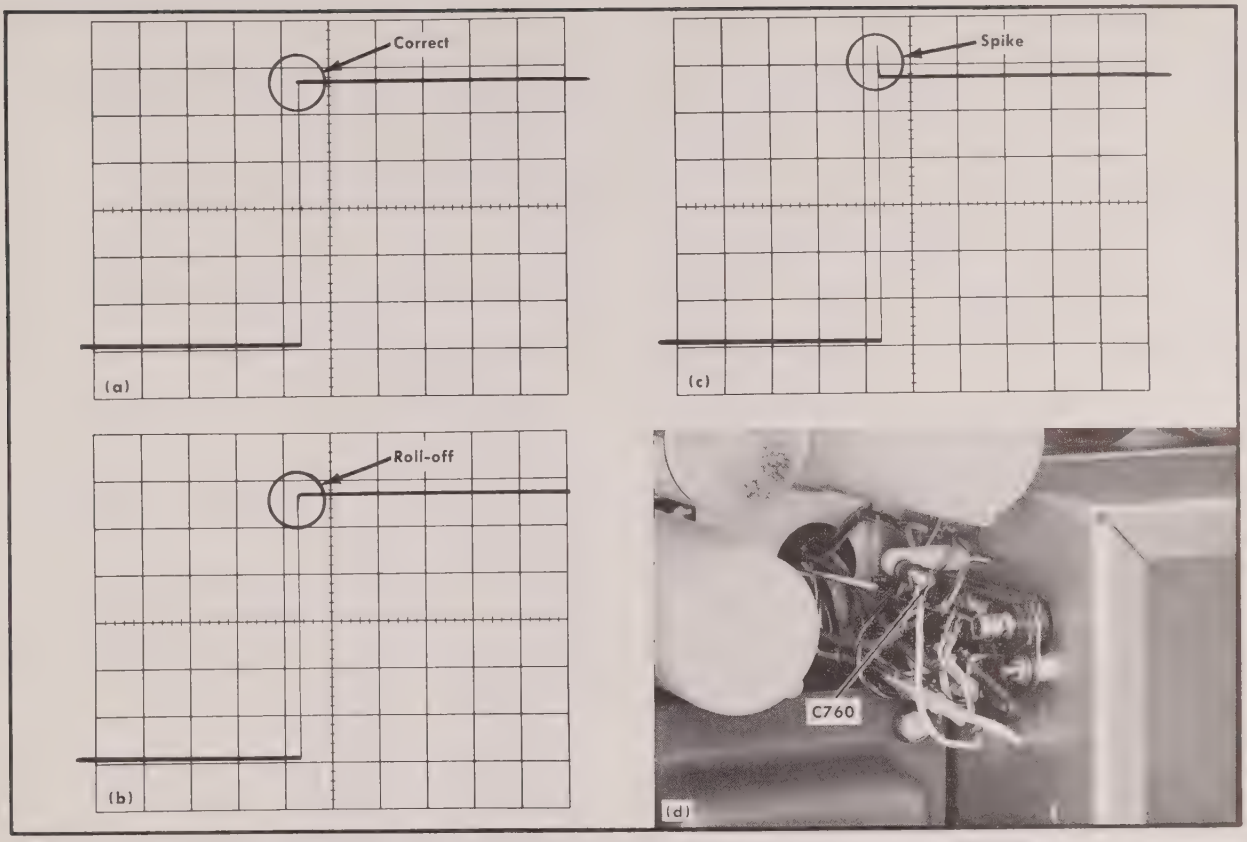


Fig. 5-18. (a) Typical crt display showing correct vertical compensation adjustment; (b) and (c) incorrect adjustment; (d) location of C760 (left side).

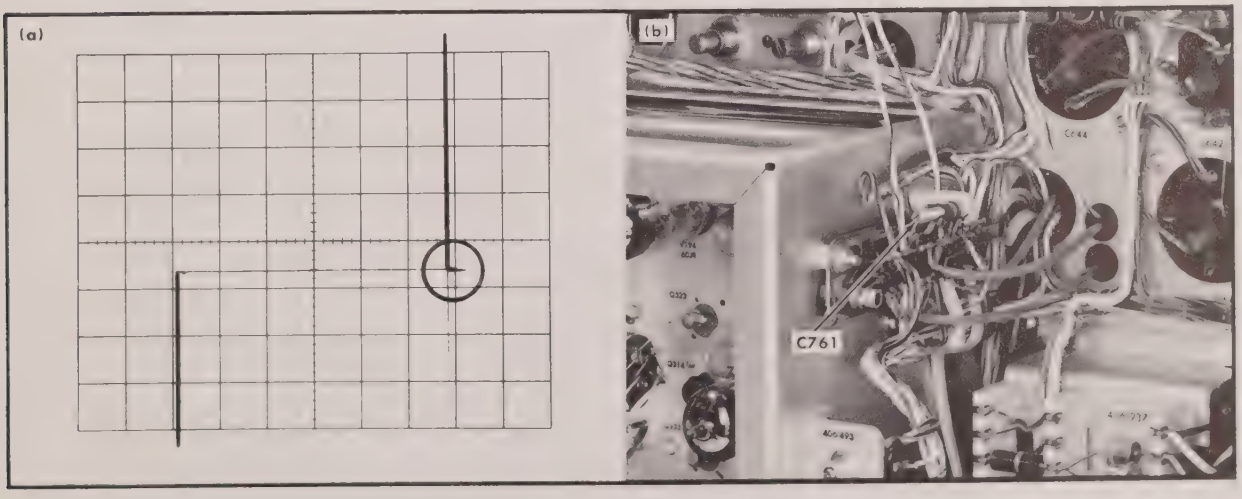


Fig. 5-19. (a) Typical crt display showing correct adjustment of horizontal compensation; (b) location of C761 (right side).

to determine the configuration and formula to use for correct deflection-plate capacitance.

The effective deflection-plate capacitance, C_{eff}, can be expressed in terms of C1, C2 and C3 as follows:

$$C_{eff} = \frac{C1 + C2}{2} + 2\ (C3)$$

Setting C_{eff} equal to 14.3 picofarads (value set at factory), the value of the variable capacitor can be calculated.

Configuration 1, Fig. 5-20a. $C3 = 7.15\,pf - \frac{C1 + C2}{4}$

Configuration 2, Fig. 5-20b. $C2 = 28.6\,pf - 4\ (C3) - C1$

a. Disconnect the power cord and isolate the Type 561A from ground.

b. Remove both plug-in units.

c. Connect the capacitance meter guard voltage to pin 21 of the vertical plug-in compartment and measure the capacitance between pin 17 and the oscilloscope chassis—this is C1.

d. Connect the capaitance meter guard voltage to pin 17 and measure the capacitance between pin 21 and the oscilloscope chassis—this is C2. (For configuration 2, connect the guard voltage to the oscilloscope chassis and measure the capacitance between pin 17 and 21—this is C3.)

e. Substitute the measured capacitance values into the equation and solve for C3 (configuration 2, solve for C2).

f. Connect the guard voltage to the oscilloscope chassis and measure the capacitance between pins 17 and 21. (For configuration 2, connect the guard voltage to pin 17 and measure the capacitance between pin 21 and the oscilloscope chassis.)

g. Adjust C760 until the measured capacitance equals the value calculated for C3 in step e (configuration 2, adjust C760 for calculated value of C2).

h. Repeat steps c through g for the horizontal (right) plug-in compartment. Fig. 5-20a shows the individual capacitances for the horizontal plug-in compartment.

17. Check Dual-Trace Chopped Blanking

a. Set the amplifier unit Mode switch to Chopped (this check can be made only with a dual-trace plug-in unit).

b. Set the amplifier unit Ac Dc Gnd switches to Gnd.

c. Position the traces about three divisions apart.

d. Set the time-base Time/Division switch to display several cycles of the waveform and adjust the triggering controls for a stable display.

e. With the CRT CATHODE SELECTOR switch in the up position, notice the overshoot on the display (see Fig. 5-21a).

f. Set the CRT CATHODE SELECTOR switch to CHOPPED BLANKING. The between-channel switching transients should be removed from the display (see Fig. 5-21b).

18. Check Crt Intensifier Circuit

a. Set the time-base Time/Division switch to 1 millisecond and the delayed sweep Time/Division switch to 0.1 millisecond (this check can be made only with a delayed sweep plug-in unit).

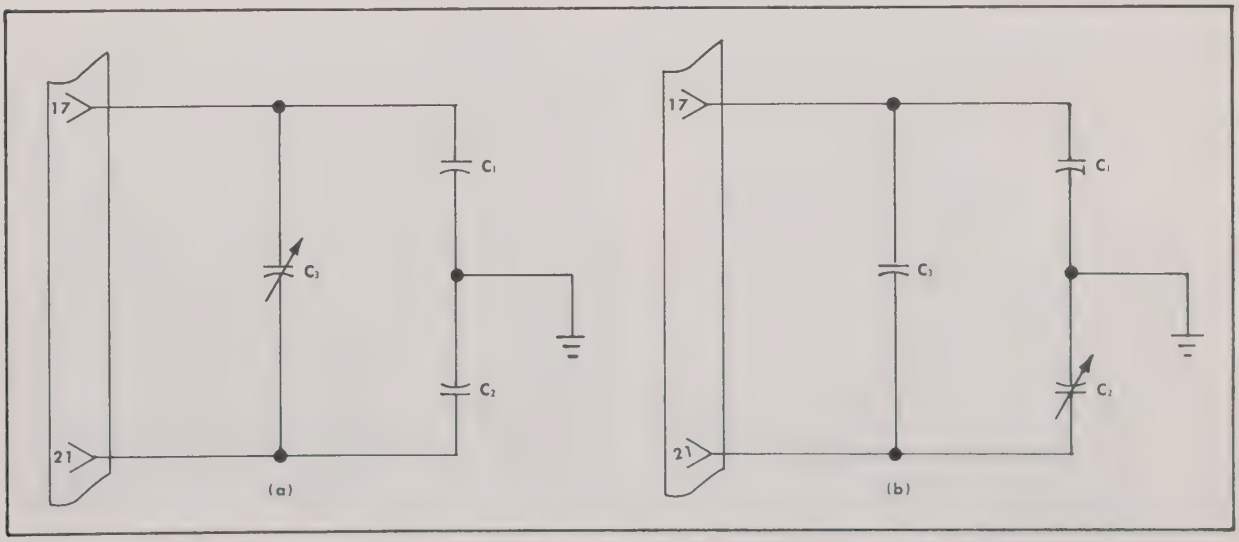


Fig. 5-20. Schematic representation of the effective crt deflection-plate capacitance; (a) configuration 1, (b) configuration 2.

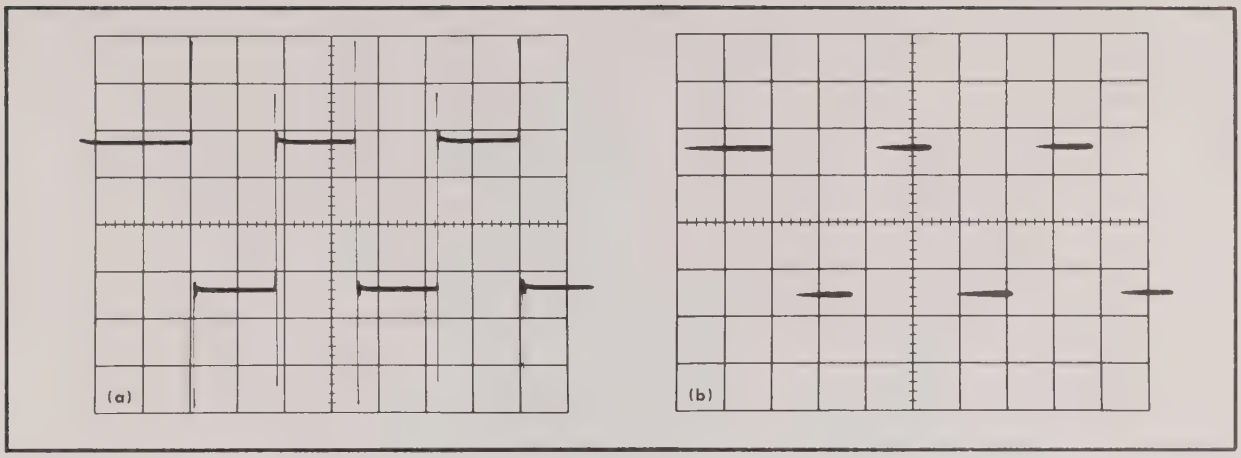


Fig. 5-21. Typical crt display showing correct chopped blanking. (a) Chopped transients visible with CRT CATHODE SELECTOR switch up (time/division, 2 microseconds); (b) transients removed with CRT CATHODE SELECTOR switch in the CHOPPED BLANKING position.

b. Set the amplifier unit mode switch to display only one channel.

c. Adjust the time-base triggering controls to produce a trace.

d. Adjust the FOCUS control and the time-base triggering control for a well-focused free-running (or automatic triggered) trace.

e. Turn the time-base Mode switch to Intensified (not triggered).

f. An intensified portion should appear on the trace (see Fig. 5-22). If the display appears only as a shortened trace, increase the INTENSITY setting slightly until the complete trace, showing an intensified portion, appears.

g. Turn the delay time control throughout its range and check that the intensified portion moves along the trace.

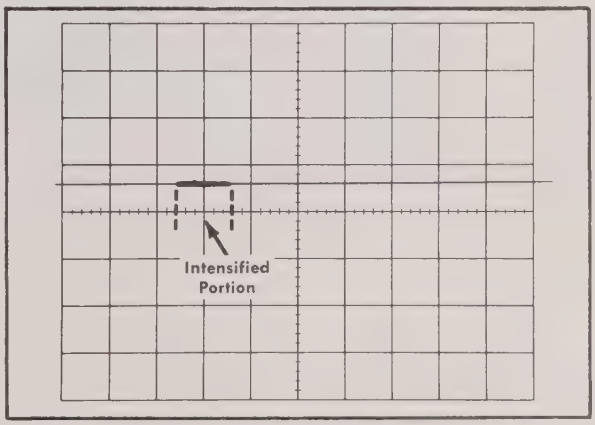


Fig. 5-22. Typical crt display showing correct intensifier circuit operation.

NOTES

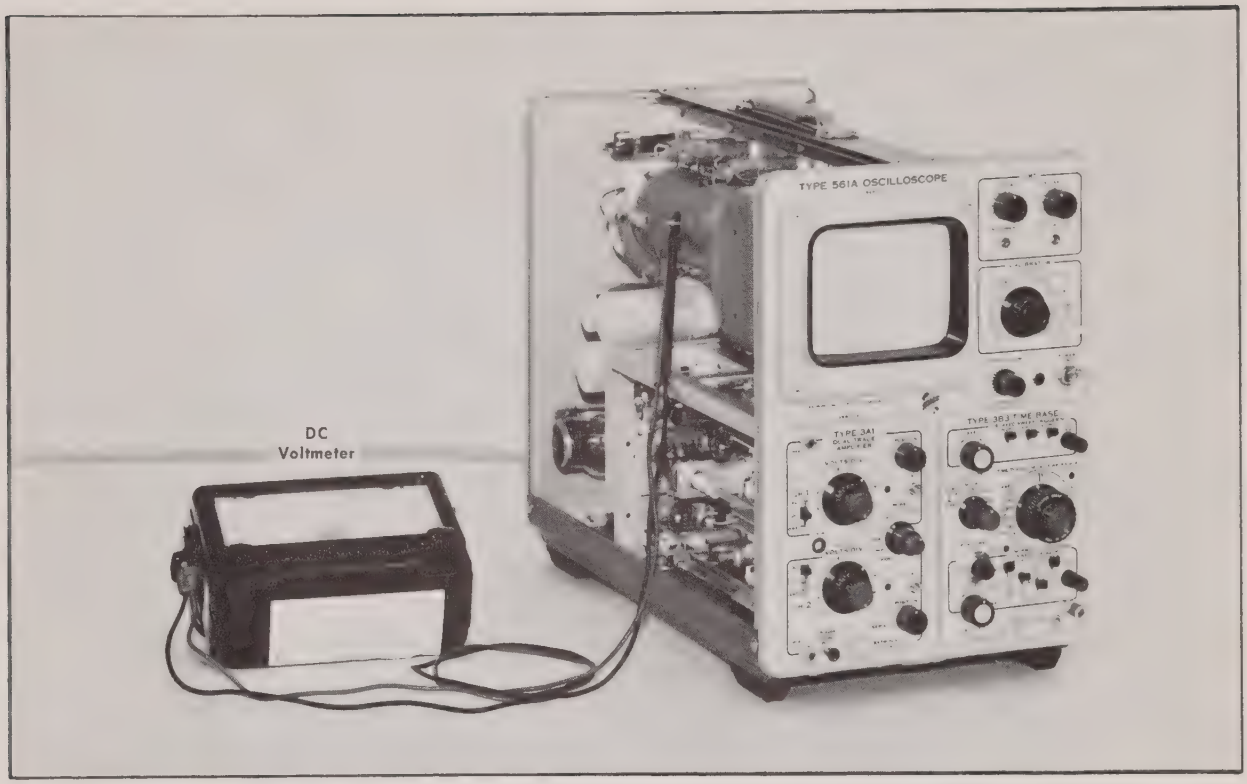


Fig. 5-23. Test equipment setup for checking crt vertical and horizontal sensitivity.

Type 561A controls	
FOCUS	Adjust for focused display
INTENSITY	**Midrange**
CALIBRATOR	**5 VOLTS**
SCALE ILLUM	Any position
POWER	ON
CRT CATHODE SELECTOR	Up
Amplifier unit controls	
Position	Midrange
Ac Dc Gnd	Ac
Volts/Division	1
Variable	Calibrated
Time-base unit controls	
Position	Midrange
Magnifier	Off
Time/Division	**10 milliseconds**
Variable	Calibrated
Triggering controls	**Automatic**

CAUTION

In steps 19 and 20 be careful not to short the crt deflection pins to chassis ground.

19. Check Crt Vertical Sensitivity

a. Test equipment setup is shown in Fig. 5-23.

b. Connect the dc voltmeter between the vertical deflection-plate pins. Be careful not to bend the pins.

c. Turn the amplifier unit Position control to move the trace to the top graticule line.

d. Note the meter reading.

e. Turn the amplifier unit Position control to move the trace to the bottom graticule line.

f. Again note the meter reading.

g. Calculate the difference in voltage between step d and f. Divide by 8 to determine the deflection voltage/division (sensitivity).

h. Sensitivity should be 19.5 volts/division, ±1 volt.

20. Check Crt Horizontal Sensitivity

a. Test equipment setup is shown in Fig. 5-23.

b. Interchange the plug-ins so the time-base unit is in the left compartment and the amplifier unit is in the right compartment.

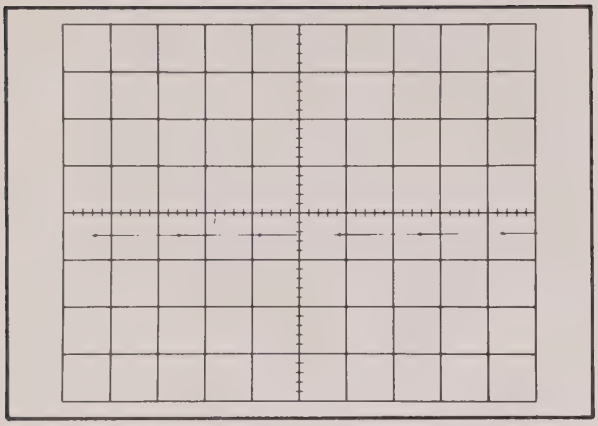


Fig. 5-24. Typical crt display showing correct intensity modulation (time/division, 10 milliseconds).

c. Connect the dc voltmeter between the vertical deflection-plate pins. Be careful not to bend the pins.

d. Adjust the FOCUS control and the time-base triggering control for a well-focused free-running (or automatic triggered) trace.

e. Turn the amplifier unit Position control to move the trace to the left graticule line.

f. Note the meter reading.

g. Turn the amplifier unit Position control to move the trace to the right graticule line.

h. Again note the meter reading.

i. Calculate the difference in voltage between step f and h. Divide by 10 to determine the deflection voltage/division (sensitivity).

j. Sensitivity should be 18.4 volts/division, ±0.9 volts.

k. Disconnect the voltmeter and return the amplifier unit to the left compartment and the time-base unit to the right compartment.

21. Check Intensity (Z-Axis) Modulation

a. Remove the ground strap between the rear-panel binding posts.

b. Connect the CALIBRATOR signal to the EXT CRT CATHODE binding post with the BNC-to-BNC and BNC-to-banana jack jumper leads.

c. Check the display for intensified dots (see Fig. 5-24). It may be necessary to reduce the INTENSITY setting slightly to see the dots.

d. Remove the jumper leads and replace the ground strap.

This completes the calibration of the Type 561A. Disconnect all test equipment. Replace the side panels. The gain of the amplifier unit and timing of the time-base unit should be checked before using the system.

NOTES

NOTES

SECTION 6
PARTS LIST and DIAGRAMS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix Field Office.

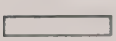
Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number including any suffix, instrument type, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix Field Office will contact you concerning any change in part number.

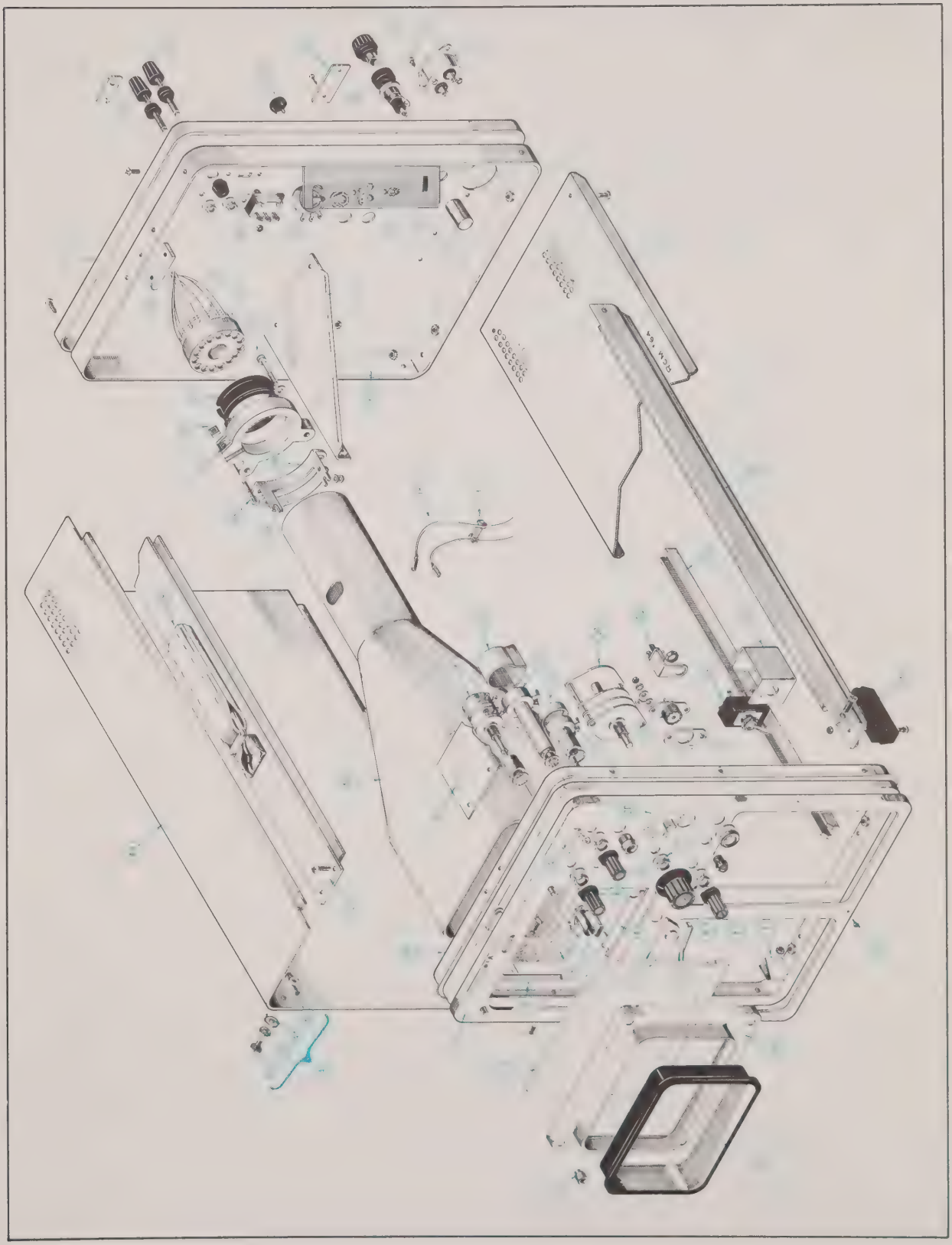
ABBREVIATIONS AND SYMBOLS

a or amp	amperes	mm	millimeter
BHS	binding head steel	meg or M	megohms or mega (10^6)
C	carbon	met.	metal
cer	ceramic	μ	micro, or 10^{-6}
cm	centimeter	n	nano, or 10^{-9}
comp	composition	Ω	ohm
cps	cycles per second	OD	outside diameter
crt	cathode-ray tube	OHS	oval head steel
CSK	counter sunk	p	pico, or 10^{-12}
dia	diameter	PHS	pan head steel
div	division	piv	peak inverse voltage
EMC	electrolytic, metal cased	plstc	plastic
EMT	electroyltic, metal tubular	PMC	paper, metal cased
ext	external	poly	polystyrene
f	farad	Prec	precision
F & I	focus and intensity	PT	paper tubular
FHS	flat head steel	PTM	paper or plastic, tubular, molded
Fil HS	fillister head steel	RHS	round head steel
g or G	giga, or 10^9	rms	root mean square
Ge	germanium	sec	second
GMV	guaranteed minimum value	Si	silicon
h	henry	S/N	serial number
hex	hexagonal	t or T	tera, or 10^{12}
HHS	hex head steel	TD	toroid
HSS	hex socket steel	THS	truss head steel
HV	high voltage	tub.	tubular
ID	inside diameter	v or V	volt
incd	incandescent	Var	variable
int	internal	w	watt
k or K	kilohms or kilo (10^3)	w/	with
kc	kilocycle	w/o	without
m	milli, or 10^{-3}	WW	wire-wound
mc	megacycle		

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number.
000X	Part removed after this serial number.
*000-000	Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, or reworked or checked components.
Use 000-000	Part number indicated is direct replacement.
	Internal screwdriver adjustment.
	Front-panel adjustment or connector.

FRONT & REAR



FRONT & REAR

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	333-0710-00			1	PANEL, front
2	385-0163-00			1	ROD, spacer bar
	- - - - - -			-	mounting hardware: (not included w/rod)
	211-0538-00			2	SCREW, 6-32 x 5/16 inch, FHS phillips
3	337-0539-00	5001	12399X	1	SHIELD, implosion
	337-0586-01	X14370		1	SHIELD, light
4	200-0426-00			1	COVER, graticule and trim assembly (See Ref. #6)
	- - - - - -			-	cover includes:
5	101-0006-00			1	TRIM, graticule cover
	- - - - - -			-	mounting hardware: (not included w/cover)
6	210-0571-00			4	NUT, knurled, graticule cover
7	344-0095-00	X8130		2	CLIP, grounding
	- - - - - -			-	mounting hardware for each: (not included w/clip)
	212-0039-00			1	SCREW, 8-32 x 3/8 inch, THS phillips
	210-0458-00			1	NUT, keps, 8-32 x 11/32 inch
8	366-0113-00	5001	10489	1	KNOB, small charcoal—SCALE ILLUM.
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
	366-0220-00	10490		1	KNOB, small charcoal—SCALE ILLUM.
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
9	366-0117-00			1	KNOB, large charcoal—CALIBRATOR
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
10	262-0497-00			1	SWITCH, wired—CALIBRATOR (See Ref. #11)
	- - - - - -			-	switch includes:
	260-0253-00			1	SWITCH, unwired—CALIBRATOR
	210-0207-00	X5501		1	LUG, solder, 3/8 inch
11	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0013-00			1	LOCKWASHER, internal, 3/8 x 11/16 inch
	210-0413-00			1	NUT, hex, 3/8-32 x 1/2 inch
12	352-0049-00	5001	12399	1	HOLDER, reflector shield
	214-0442-00	12400		1	SPRING, eyebrow
13	337-0540-00	5001	12399	1	SHIELD, reflector
	387-0934-00	12400		1	PLATE, light reflector
14	406-0939-00	X10658		1	BRACKET, graticule light mounting
	- - - - - -			-	mounting hardware: (not included w/bracket)
	211-0538-00			2	SCREW, 6-32 x 5/16 inch, FHS phillips
15	366-0113-00	5001	13979	1	KNOB, small charcoal—INTENSITY
	366-0220-00	13980		1	KNOB, small charcoal—INTENSITY
	- - - - - -			-	knob includes:
	213-0004-00	5001	13979	1	SCREW, set, 6-32 x 3/16 inch, HSS
	213-0020-00	13980		1	SCREW, set, 6-32 x 1/8 inch, HSS
16	366-0113-00	5001	13979	1	KNOB, small charcoal—FOCUS
	366-0220-00	13980		1	KNOB, small charcoal—FOCUS
	- - - - - -			-	knob includes:
	213-0004-00	5001	13979	1	SCREW, set, 6-32 x 3/16 inch, HSS
	213-0020-00	13980		1	SCREW, set, 6-32 x 1/8 inch, HSS

FRONT & REAR *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
17	136-0035-00	5001	10657	2	SOCKET, graticule light
	- - - - - -			-	mounting hardware for each: (not included w/socket)
	211-0534-00			1	SCREW, 6-32 x 5/16 inch, PHS w/lockwasher
	210-0803-00			1	WASHER, 6L x 3/8 inch
	136-0152-00	10658		2	SOCKET, lamp
18	354-0181-00	5001	12399	1	RING, crt shockmount
	124-0167-00	12400	16609	1	STRIP, felt
	348-0090-00	16610		4	CUSHION sponge, CRT
19	352-0044-00			1	HOLDER, form, coil, crt
	- - - - - -			-	mounting hardware: (not included w/holder)
	211-0011-00	5001	13399	1	SCREW, 4-40 x 5/16 inch, BHS
	211-0110-00	13400		1	SCREW, 4-40 x 5/16 inch, PHB, phillips
	210-0004-00			1	LOCKWASHER, internal, #4
	210-0406-00			1	NUT, hex, 4-40 x 3/16 inch
20	- - - - - -			1	POT
	- - - - - -			-	mounting hardware: (not included w/pot)
	210-0590-00			1	NUT, hex., 3/8-32 x 7/16 inch
	210-0012-00			1	LOCKWASHER, internal, 3/8 x 1/2 inch
	210-0840-00	5001	10489	1	WASHER, .390 ID x 9/16 inch OD
	210-0978-00	10490		1	WASHER, 3/8 ID x 1/2 inch OD
	210-0413-00	5001	10489	1	NUT, hex, 3/8-32 x 1/2 inch
	210-0590-00	10490		1	NUT, hex, 3/8-32 x 7/16 inch
21	131-0064-00	5001	7894	1	CONNECTOR, UHF
	131-0279-00	7895		1	CONNECTOR, BNC
	- - - - - -			-	mounting hardware: (not included w/connector)
	210-0224-00			1	LUG, solder, 1/4 inch
	210-0812-00			2	WASHER, fiber, #10
	210-0004-00			2	LOCKWASHER, internal, #4
	210-0406-00			2	NUT, hex, 4-40 x 3/16 inch
22	406-0244-00			1	BRACKET, nylon, insulating
	210-0961-00	X7895	10638X	1	WASHER, plastic, 3/8 ID x 13/16 inch OD
23	- - - - - -			2	POT
	- - - - - -			-	mounting hardware for each: (not included w/pot)
	210-0013-00			1	LOCKWASHER, internal, 3/8 x 11/16 inch
	210-0840-00			1	WASHER, .390 ID x 9/16 inch OD
	210-0413-00	5001	13979	1	NUT, hex, 3/8-32 x 1/2 inch
	210-0590-00	13980		1	NUT, hex, 3/8-32 x 7/16 inch
24	348-0015-00	5001	10657	4	CUSHION, rubber ball
	348-0014-00	5001	10657	4	CUSHION, molded black (holder)
	- - - - - -			-	mounting hardware for each: (not included w/cushion)
	212-0010-00			1	SCREW, 8-32 x 5/8 inch, BHS
	210-0458-00			1	NUT, keps, 8-32 x 11/32 inch
	348-0042-00	10658	13259	4	FOOT, molded
	348-0052-00	13260		4	FOOT, anti-slide
	- - - - - -			-	mounting hardware for each: (not included w/foot)
	212-0071-00			2	SCREW, 8-32 x 1 inch, FHS
	210-0458-00			2	NUT, keps, 8-32 x 11/32 inch
25	213-0045-00			1	SCREW, self-tapping, 4-40 x 5/16 inch, PHS phillips

FRONT & REAR *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
26	260-0014-00			1	SWITCH, toggle—POWER ON
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0414-00			1	NUT, hex, $^{15}/_{32}$-32 x $^{9}/_{16}$ inch
	354-0055-00			1	RING, locking, switch
	210-0902-00			1	WASHER, .470 ID x $^{21}/_{32}$ inch OD
	210-0473-00			1	NUT, switch, $^{15}/_{32}$-32 x $^{5}/_{64}$ inch, 12 sided
27	337-0398-00			1	SHIELD, power switch
28	122-0107-00	X10658	14479	2	ANGLE, rail, bottom
	122-0118-00	14480		2	ANGLE, rail, bottom
	- - - - - -			-	mounting hardware for each: (not included w/angle)
	212-0039-00			4	SCREW, 8-32 x $^{3}/_{8}$ inch, THS phillips
	210-0458-00			4	NUT, keps, 8-32 x $^{11}/_{32}$ inch
29	351-0038-00			2	GUIDE, rail track, plug-in
	- - - - - -			-	mounting hardware for each: (not included w/guide)
	211-0541-00			2	SCREW, 6-32 x $^{1}/_{4}$ inch, FHS phillips
30	136-0047-00			1	SOCKET, light
31	- - - - - -			1	POT
	- - - - - -			-	mounting hardware: (not included w/pot)
	210-0207-00			1	LUG, solder, $^{3}/_{8}$ inch
	210-0012-00			1	LOCKWASHER, internal, $^{3}/_{8}$ x $^{1}/_{2}$ inch
	210-0494-00			1	NUT, hex, $^{3}/_{8}$-32 x $^{1}/_{2}$ x $^{11}/_{16}$ inch
	210-0013-00			1	LOCKWASHER, internal, $^{3}/_{8}$ x $^{11}/_{16}$ inch
	358-0010-00			1	BUSHING, $^{3}/_{8}$-32 x $^{9}/_{16}$ inch
32	200-0247-00	5001	13689X	1	CAP, pot
33	200-0269-00			2	COVER, pot
34	- - - - - -			1	POT
	- - - - - -			-	mounting hardware: (not included w/pot)
	210-0207-00			1	LUG, solder, $^{3}/_{8}$ inch
	210-0012-00			1	LOCKWASHER, internal, $^{3}/_{8}$ x $^{1}/_{2}$ inch
	210-0421-00			1	NUT, hex, $^{3}/_{8}$-32 x $^{1}/_{2}$ x $^{7}/_{16}$ inch
	210-0013-00			1	LOCKWASHER, internal, $^{3}/_{8}$ x $^{11}/_{16}$ inch
	358-0010-00			1	BUSHING, $^{3}/_{8}$-32 x $^{9}/_{16}$ inch
35	337-0528-00			1	SHIELD, focus and intensity
	- - - - - -			-	mounting hardware: (not included w/shield)
	211-0541-00			3	SCREW, 6-32 x $^{1}/_{4}$ inch, FHS phillips
36	387-0681-00			1	PLATE, front sub-panel
	- - - - - -			-	plate includes:
	354-0057-00			1	RING, ornamental

FRONT & REAR *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
37	381-0182-00	5001	10657	1	BAR, top support, w/handle (See Ref. #39)
	381-0213-00	10658		1	BAR, top support, w/handle (See Ref. #39)
	- - - - - -			-	bar includes:
38	367-0040-00			1	HANDLE, assembly
	- - - - - -			-	handle includes:
	367-0011-00			1	HANDLE
	343-0073-00			2	CLAMP, cover, handle
	211-0507-00			4	SCREW, 6-32 x 5/16 inch, BHS
	210-0457-00			4	NUT, keps, 6-32 x 5/16 inch
39	- - - - - -			-	mounting hardware: (not included w/bar)
	212-0039-00			4	SCREW, 8-32 x 3/8 inch, THS phillips
	381-0073-00			2	BAR, retaining
40	387-0300-00	5001	10657	2	PLATE, cabinet side
	387-0725-00	10658		2	PLATE, cabinet side
	- - - - - -			-	each plate includes:
41	214-0057-00			2	FASTENER, cabinet latch assembly
	- - - - - -			-	each fastener includes:
42	213-0033-00			1	SCREW, fastening
43	210-0847-00			1	WASHER, nylon, .164 ID x .500 inch OD
44	105-0007-00			1	STOP
45	210-0480-00			1	NUT, latch, nylon
46	337-0530-00			1	SHIELD, crt
	- - - - - -			-	mounting hardware: (not included w/shield)
	211-0504-00			4	SCREW, 6-32 x 1/4 inch, BHS
	211-0511-00			1	SCREW, 6-32 x 1/2 inch, BHS
	166-0005-00	5001	10657X	1	TUBE, spacer
47	344-0047-00	5001	12308	1	CLIP, deflection plate
	344-0111-00	12309		1	CLIP, deflection plate
48	175-0586-00	5001	6634	1	WIRE, crt lead, .960 foot, striped brown w/connector
	175-0641-00	6635		1	WIRE, crt lead, .833 foot, striped brown w/connector
	175-0594-00	5001	6634	1	WIRE, crt lead, 1 foot, striped blue w/connector
	175-0642-00	6635		1	WIRE, crt lead, .833 foot, striped blue w/connector
	175-0592-00			1	WIRE, crt lead, .960 foot, striped green w/connector
	175-0595-00			1	WIRE, crt lead, .960 foot, striped red w/connector
49	387-0682-00	5001	10657	1	PLATE, rear sub-panel
	387-0813-00	10658		1	PLATE, rear sub-panel
	- - - - - -			-	plate includes:
	354-0057-00			1	RING, ornamental (not shown)
50	406-0730-00			1	BRACKET, adjusting
	- - - - - -			-	mounting hardware: (not included w/bracket)
	211-0507-00			4	SCREW, 6-32 x 5/16 inch, BHS
	210-0803-00			4	WASHER, 6L x 3/8 inch
	210-0457-00			4	NUT, keps, 6-32 x 5/16 inch

FRONT & REAR *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
51	354-0147-00	5001	8776	1	RING, clamping (See Ref. #53 & #54)
	354-0212-00	8780		1	RING, clamping, screw assembly (See Ref. #53 & #54)
	- - - - - -			-	ring includes:
	354-0211-00			1	RING, clamping
52	124-0160-00			1	STRIP, liner, crt lamp
	- - - - - -			-	mounting hardware: (not included w/ring)
53	211-0576-00			2	SCREW, 6-32 x 7/8 inch, socket head
	210-0949-00			2	WASHER, 9/64 ID x 1/2 inch OD
54	214-0207-00			1	NUT, adjusting, securing
55	211-0560-00			1	SCREW, 6-32 x 1 inch, RHS
56	210-0407-00	5001	11648	1	NUT, square, 6-32 x 5/16 inch
	220-0419-00	11649		1	NUT, hex., 6-32 x 1/4 inch
57	387-0352-00			1	PLATE, gusset
	- - - - - -			-	mounting hardware: (not included w/plate)
	211-0559-00			2	SCREW, 6-32 x 3/8 inch, FHS phillips
58	- - - - - -			1	TRANSISTOR (not shown)
	- - - - - -			-	mounting hardware: (not included w/transistor)
	211-0510-00			2	SCREW, 6-32 x 3/8 inch, BHS
	210-0006-00			1	LOCKWASHER, internal, #6
	210-0202-00			1	LUG, solder, SE #6
	210-0407-00			2	NUT, hex, 6-32 x 1/4 inch
59	- - - - - -	5001	10657	1	POT, miniature
	- - - - - -			-	mounting hardware: (not included w/pot)
	406-0635-00			1	BRACKET, pot mounting
	213-0045-00			2	SCREW, self-tapping, 4-40 x 5/16 inch, FHS phillips
	210-0438-00			2	NUT, hex, 1-72 x 5/32 inch
	- - - - - -	10658		1	POT
	- - - - - -			-	mounting hardware: (not included w/pot)
	210-0012-00			1	LOCKWASHER, internal, 3/8 x 1/2 inch
	210-0840-00			1	WASHER, .390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex, 3/8-32 x 1/2 inch
60	260-0449-00			1	SWITCH, slide—CRT CATHODE SELECTOR
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0406-00			2	NUT, hex, 4-40 x 3/16 inch
61	136-0133-00	5001	9389	1	SOCKET, crt, assembly
	136-0176-00	9390		1	SOCKET, crt, assembly
	- - - - - -			-	socket includes:
	136-0117-00			1	SOCKET, crt
	131-0178-00			9	CONNECTOR, cable end
62	387-0393-00			1	PLATE, back, crt cathode
	- - - - - -			-	mounting hardware: (not included w/plate alone)
	213-0086-00			2	SCREW, thread cutting, 2-32 x 7/16 inch, PHS

FRONT & REAR *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
63	387-0683-00	5001	10657	1	PLATE, rear overlay
	387-0729-00	10658		1	PLATE, rear overlay
	- - - - - -			-	mounting hardware: (not included w/plate)
	213-0104-00			2	SCREW, thread forming, 6-32 x 3/8 inch, THS phillips
64	386-0427-00			1	PLATE, ground
65	129-0063-00			1	POST, binding
	- - - - - -			-	mounting hardware: (not included w/post)
	210-0445-00	5001	9739	1	NUT, hex, 10-32 x 3/8 inch
	220-0410-00	9740		1	NUT, keps, 10-32 x 3/8 inch
	210-0010-00	5001	9739X	1	LOCKWASHER, internal, #10
66	129-0063-00			1	POST, binding
	- - - - - -			-	mounting hardware: (not included w/post)
	358-0169-00			1	BUSHING, binding post
	210-0206-00	5001	9739X	1	LUG, solder, SE #10
	210-0010-00	5001	9739X	1	LOCKWASHER, internal, #10
	210-0445-00	5001	9739	2	NUT, hex, 10-32 x 3/8 inch
	220-0410-00	9740		1	NUT, keps, 10-32 x 3/8 inch
67	134-0067-00	X10658		4	PLUG, "D" hole, nylon
68	334-0650-00	5001	5788	1	TAG, voltage rating
	334-0661-00	5789		1	TAG, voltage rating
	- - - - - -			-	mounting hardware: (not included w/tag)
	213-0088-00			2	SCREW, thread forming, 4-40 x 1/4 inch, PHS phillips
69	352-0002-00			1	HOLDER, fuse assembly
	- - - - - -			-	holder includes:
	352-0010-00			1	HOLDER, fuse
	210-0873-00			1	WASHER, rubber
	- - - - - -			1	NUT, fuse holder
70	200-0582-00			1	CAP, fuse
71	131-0150-00			1	CONNECTOR, motor base (See Ref. #72)
	- - - - - -			-	connector includes:
	129-0041-00			1	POST, ground, 4-40 thread one end
	200-0185-00			1	COVER, 3 wire motor base
	205-0014-00			1	SHELL, mounting
	210-0003-00			2	LOCKWASHER, external, #4
	210-0551-00			2	NUT, hex, 4-40 x 1/4 inch
	211-0015-00			1	SCREW, 4-40 x 1/2 inch, RHS
	214-0078-00			2	PIN, connecting
	377-0041-00			1	INSERT, black urea
72	- - - - - -			-	mounting hardware: (not included w/connector)
	213-0104-00			2	SCREW, thread forming, 6-32 x 3/8 inch, THS phillips

FRONT & REAR *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
73	387-0294-00	5001	10657	1	PLATE, bottom
	- - - - - -			-	mounting hardware: (not included w/plate)
	212-0039-00			4	SCREW, 8-32 x $^{3}/_{8}$ inch, THS phillips
	210-0458-00			4	NUT, keps, 8-32 x $^{11}/_{32}$ inch
	387-0812-00	10658		1	PLATE, bottom
	- - - - - -			-	mounting hardware: (not included w/plate)
	212-0075-00			9	SCREW, 8-32 x $^{1}/_{4}$ inch, THS phillips
74	200-0237-00	5001	10649X	1	COVER, insulating, fuse holder
75	124-0119-00	X13900		1	STRIP, ceramic, $^{7}/_{16}$ inch x 2 notches
	- - - - - -			-	strip includes:
	355-0046-00			1	STUD, nylon
	- - - - - -			-	mounting hardware: (not included w/strip)
	361-0008-00			1	SPACER, nylon, .156 inch

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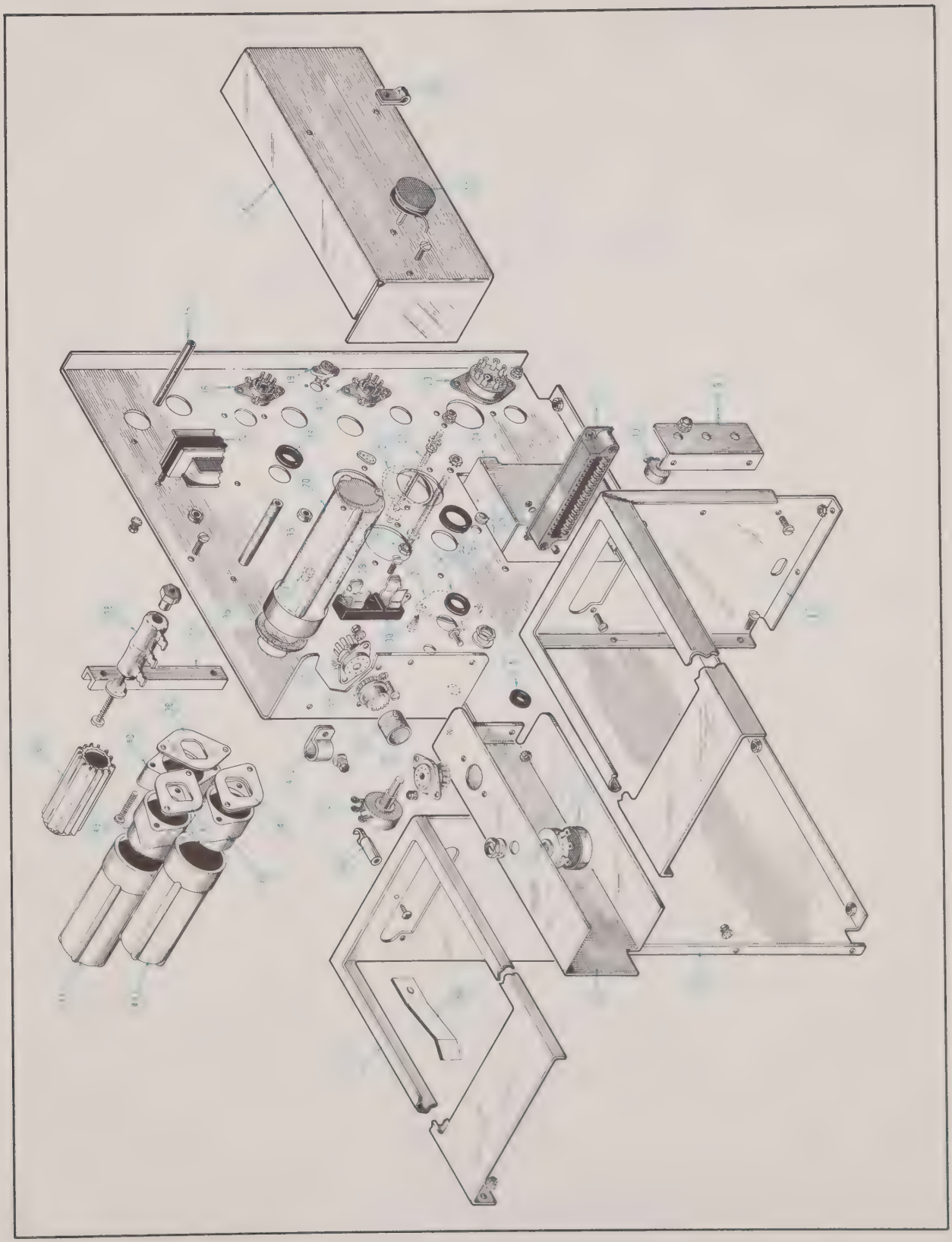


CHASSIS

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	406-0608-00	5001	10657	1	BRACKET, plug-in housing, left
	406-0941-00	10658		1	BRACKET, plug-in housing, left
	- - - - - -			-	mounting hardware: (not included w/bracket)
	211-0538-00			1	SCREW, 6-32 x 5/16 inch, FHS phillips
	210-0006-00			1	LOCKWASHER, internal, #6
	210-0407-00			1	NUT, hex, 6-32 x 1/4 inch
	212-0039-00			1	SCREW, 8-32 x 3/8 inch, THS phillips
	210-0458-00			1	NUT, keps, 8-32 x 11/32 inch
2	- - - - - -			3	POT
	- - - - - -			-	mounting hardware for each: (not included w/pot)
	210-0840-00			1	WASHER, .390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex, 3/8-32 x 1/2 inch
3	136-0014-00			1	SOCKET, STM9
	- - - - - -			-	mounting hardware: (not included w/socket)
	211-0033-00			2	SCREW, 6-32 x 5/16 inch, BHS
	210-0201-00			2	LUG, solder, SE #4
	210-0004-00			2	LOCKWASHER, internal, #4
	210-0406-00			2	NUT, hex, 4-40 x 3/16 inch
4	348-0005-00			1	GROMMET, 1/2 inch
5	200-0247-00			1	CAP, pot
6	441-0445-00			1	CHASSIS, calibrator
	- - - - - -			-	mounting hardware: (not included w/chassis)
	211-0507-00			2	SCREFW, 6-32 x 5/16 inch, BHS
	210-0457-00			2	NUT, keps, 6-32 x 5/16 inch
7	441-0446-00	5001	10657	1	CHASSIS, indicator
	441-0511-00	10658	12999	1	CHASSIS, indicator
	441-0551-00	13000		1	CHASSIS, indicator
	- - - - - -			-	mounting hardware: (not included w/chassis)
	212-0070-00			4	SCREW, 8-32 x 5/16 inch, FHS phillips
	212-0039-00			3	SCREW, 8-32 x 3/8 inch, THS phillips
	211-0559-00			3	SCREW, 6-32 x 3/8 inch, FHS phillips
	210-0006-00			3	LOCKWASHER, internal, #6
	210-0407-00			3	NUT, hex, 6-32 x 1/4 inch
8	406-0607-00	5001	10657	1	BRACKET, plug-in housing, right
	406-0940-00	10658		1	BRACKET, plug-in housing, right
	- - - - - -			-	mounting hardware: (not included w/bracket)
	211-0538-00			1	SCREW, 6-32 x 5/16 inch, FHS phillips
	210-0006-00			1	LOCKWASHER, internal, #6
	210-0407-00			1	NUT, hex, 6-32 x 1/4 inch
	212-0039-00			1	SCREW, 8-32 x 3/8 inch, THS phillips
	210-0458-00			1	NUT, keps, 8-32 x 11/32 inch
	212-0004-00			5	SCREW, 8-32 x 5/16 inch, BHS
	210-0008-00			5	LOCKWASHER, internal, #8
	210-0409-00			5	NUT, hex, 8-32 x 5/16 inch

CHASSIS *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
9	406-893	X6635		1	BRACKET, pot
	- - - -			-	mounting hardware: (not included w/bracket)
	211-507			2	SCREW, 6-32 x 5/16 inch, BHS
10	- - - -	X6635		3	POT, miniature
	- - - -			-	mounting hardware for each: (not included w/pot)
	210-046			1	LOCKWASHER, internal, .400 OD x .261 inch ID
	210-940			1	WASHER, 1/4 ID x 3/8 inch OD
	210-583			1	NUT, hex, 1/4-32 x 5/16 inch
11	131-148			2	CONNECTOR, 24 contact, female
	- - - -			-	mounting hardware for each: (not included w/connector)
	211-014			2	SCREW, 4-40 x 1/2 inch, BHS
	166-029			2	TUBE, spacer
	210-004			2	LOCKWASHER, internal, #4
	210-406			2	NUT, hex, 4-40 x 3/16 inch
12	214-210			1	SPOOL, solder, assembly
	- - - -			-	mounting hardware: (not included w/spool)
	361-007			1	SPACER, nylon, .063 inch
13	343-001			1	CLAMP, cable, 1/8 inch
	- - - -			-	mounting hardware: (not included w/clamp)
	211-510			1	SCREW, 6-32 x 3/8 inch, BHS
	210-803			1	WASHER, 6L x 3/8 inch
14	337-529			1	SHIELD, high voltage
	- - - -			-	mounting hardware: (not included w/shield)
	211-507			3	SCREW, 6-32 x 5/16 inch, BHS
15	385-124			1	ROD, aluminum
	- - - -			-	mounting hardware: (not included w/rod)
	211-507			1	SCREW, 6-32 x 5/16 inch, BHS
16	136-008			3	SOCKET, STM7G
	- - - -			-	mounting hardware for each: (not included w/socket)
	213-044			2	SCREW, thread cutting, 5-32 x 3/16 inch, PHS phillips
17	346-001			1	STRAP, high voltage transformer
	- - - -			-	mounting hardware: (not included w/strap)
	210-004			2	LOCKWASHER, internal, #4
	210-406			2	NUT, hex, 4-40 x 3/16 inch
18	348-012			2	GROMMET, 5/8 inch
19	136-095	5001	12109	3	SOCKET, 4 pin transistor
	136-181	12110		3	SOCKET, 4 pin transistor
	- - - -			-	mounting hardware for each: (not included w/socket)
	213-113	5001	12109	2	SCREW, thread forming, 2-32 x 5/16 inch, RHS phillips
	354-234	12110		1	RING, locking, transistor socket
20	200-261			1	COVER, capacitor
21	343-074			1	CLAMP, tube

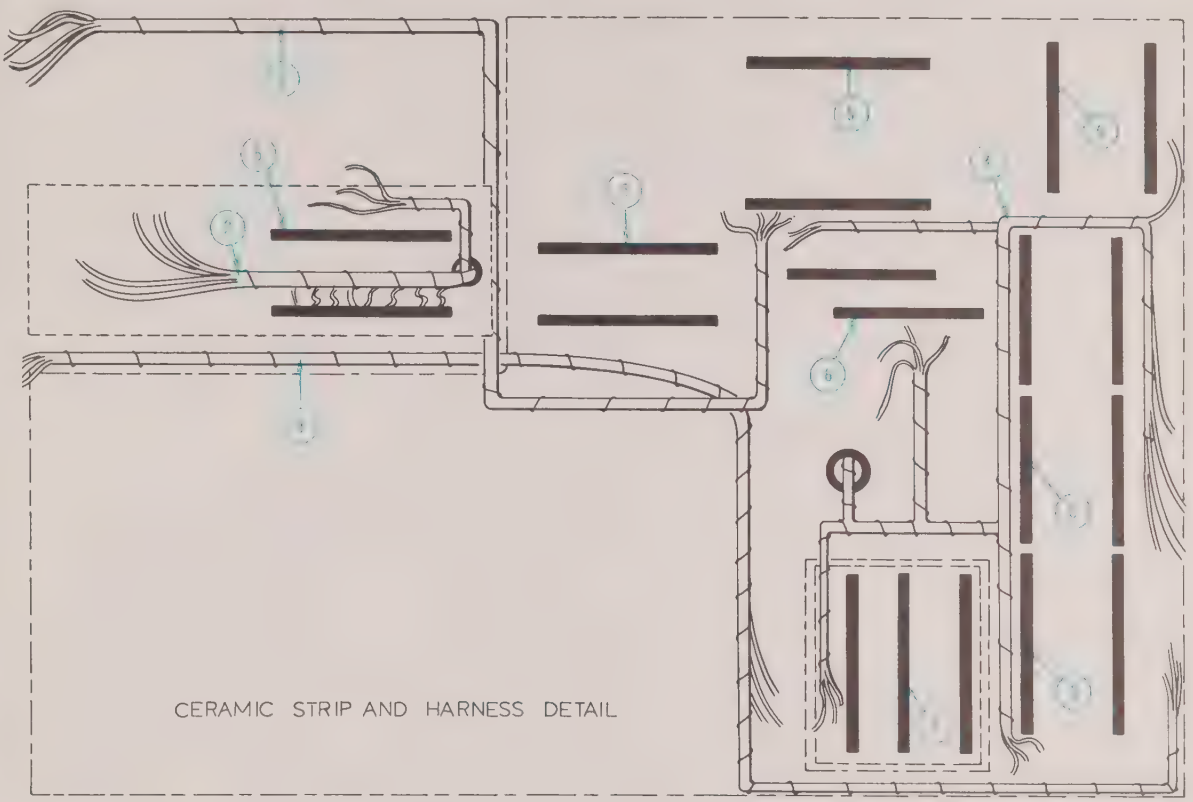
CHASSIS *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
22	355-0070-00			1	STUD, 8-32 x 4¾ inches
	- - - - - -			-	mounting hardware: (not included w/stud)
	210-0008-00			2	LOCKWASHER, internal, #8
	210-0409-00			2	NUT, hex, (8-32 x 5/16 inch
23	136-0013-00			1	SOCKET, STM8
	- - - - - -			-	mounting hardware: (not included w/socket)
	211-0538-00			2	SCREW, 6-32 x 5/16 inch, FHS phillips
	210-0006-00			2	LOCKWASHER, internal, #6
	210-0407-00			2	NUT, hex, 6-32 x 1/4 inch
24	406-0617-00	5001	10657	1	BRACKET, transformer
	406-0937-00	10658		1	BRACKET, transformer
25	348-0003-00			2	GROMMET, 5/16 inch
26	348-0006-00			2	GROMMET, 3/4 inch
27	260-0071-00	5001	12112	1	SWITCH, thermal cutout
	260-0157-00	12113		1	SWITCH, thermal cutout
	- - - - - -			-	mounting hardware: (not included w/switch)
	213-0044-00			2	SCREW, thread cutting, 5-32 x 3/16 inch, PHS phillips
28	212-0515-00			4	SCREW, 10-32 x 2¼ inches, HHS
	210-0812-00			4	WASHER, fiber, #10
	210-0010-00			4	LOCKWASHER, internal, #10
	210-0564-00			4	NUT, hex, 10-32 x 3/8 inch
29	385-0137-00			1	ROD, delrin
	- - - - - -			-	mounting hardware: (not included w/rod)
	213-0041-00			1	SCREW, thread cutting, 6-32 x 3/8 inch, THS phillips
30	352-0031-00			1	HOLDER, fuse, single
	- - - - - -			-	mounting hardware: (not included w/holder)
	211-0507-00			1	SCREW, 6-32 x 5/16 inch, BHS
	210-0006-00			1	LOCKWASHER, internal, #6
	210-0407-00			1	NUT, hex, 6-32 x 1/4 inch
31	200-0249-00			1	COVER, socket
32	136-0099-00			1	SOCKET, 9 pin, cable end
33	136-0015-00			1	SOCKET, STM9G
	- - - - - -			-	mounting hardware: (not included w/lockwasher
	211-0033-00			2	SCREW, 4-40 x 5/16 inch, PHS w/lockwasher
	210-0004-00			2	LOCKWASHER, internal, #4
	210-0406-00			2	NUT, hex, 4-40 x 3/16 inch
34	348-0031-00			2	GROMMET, snap-in
35	385-0097-00			2	ROD, nylon
	- - - - - -			-	mounting hardware for each: (not included w/rod)
	211-0507-00			1	SCREW, 6-32 x 5/16 inch, BHS
36	210-0952-00			1	WASHER, insulating, 1.440 OD x .900 inch ID
37	406-0938-00	X10658		1	BRACKET, crt shield support
	- - - - - -			-	mounting hardware: (not included w/bracket)
	211-0513-00			2	SCREW, 6-32 x 5/8 inch, BHS

CHASSIS *(Cont'd)*

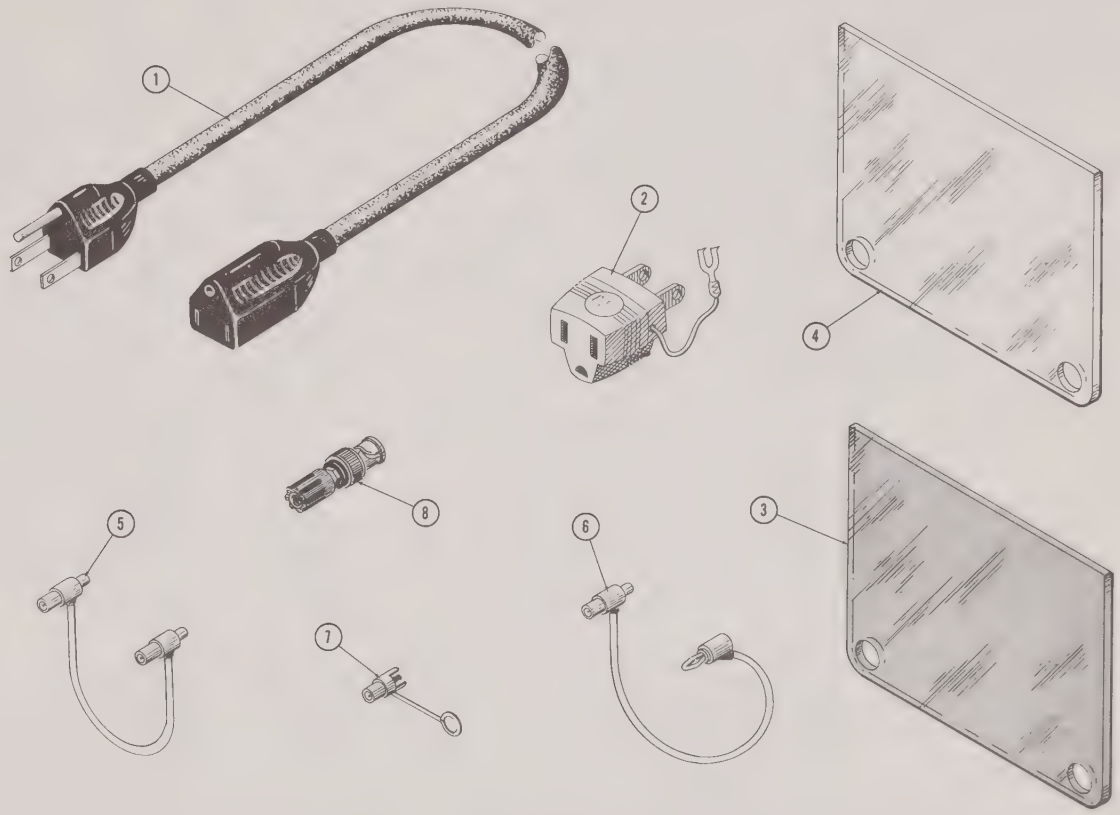
REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
38	- - - - - -			3	RESISTOR, 20 watt
	- - - - - -			-	mounting hardware for each: (not included w/resistor)
	212-0037-00			1	SCREW, 8-32 x 1 3/4 inches, Fil HS
	210-0808-00			1	WASHER, resistor centering
	210-0462-00			1	NUT, hex, resistor mounting
	212-0001-00			1	SCREW, 8-32 x 1/4 inch, BHS
39	386-0255-00			1	PLATE, metal, large capacitor
	- - - - - -			-	mounting hardware: (not included w/plate)
	211-0534-00	5001	12112	2	SCREW, 6-32 x 5/16 inch, PHS w/lockwasher
	211-0588-00	12113		2	SCREW, 6-32 x 3/4 inch, HHS
	210-0006-00			2	LOCKWASHER, internal, #6
	210-0407-00			2	NUT, hex, 6-32 x 1/4 inch
40	432-0048-00	X12113		2	BASE, mounting, large capacitor
41	337-0649-00	X12113		1	SHIELD, heat dissipating
42	386-0254-00			1	PLATE, fiber, large capacitor
	- - - - - -			-	mounting hardware: (not included w/plate)
	211-0514-00	5001	12112	2	SCREW, 6-32 x 3/4 inch, BHS
	211-0588-00	12113		2	SCREW, 6-32 x 3/4 inch, HHS
	210-0006-00			2	LOCKWASHER, internal, #6
	210-0407-00			2	NUT, hex, 6-32 x 1/4 inch
43	432-0044-00	5001	12112	1	BASE, mounting, large capacitor
	432-0048-00	12113		1	BASE, mounting, large capacitor
44	200-0259-00	5001	12112	1	COVER, capacitor, 3 9/16 inches
	200-0258-00	12113		1	COVER, capacitor, 3 1/32 inches
45	200-0258-00			1	COVER, capacitor, 3 1/32 inches
46	386-0254-00			1	PLATE, fiber, large capacitor
	- - - - - -			-	mounting hardware: (not included w/plate)
	211-0543-00	5001	12112	2	SCREW, 6-32 x 5/16 inch, RHS
	211-0588-00	12113		2	SCREW, 6-32 x 3/4 inch, HHS
	210-0006-00			2	LOCKWASHER, internal, #6
	210-0407-00			2	NUT, hex, 6-32 x 1/4 inch
47	343-0005-00			1	CLAMP, cable, 7/16 inch
	- - - - - -			-	mounting hardware: (not included w/clamp)
	211-0510-00			1	SCREW, 6-32 x 3/8 inch, BHS
	210-0803-00			1	WASHER, 6L x 3/8 inch
	210-0006-00			1	LOCKWASHER, internal, #6
	210-0407-00			1	NUT, hex, 6-32 x 1/4 inch
48	136-0015-00			4	SOCKET, STM9G
	- - - - - -			-	mounting hardware for each: (not included w/socket)
	213-0044-00			2	SCREW, thread cutting, 5-32 x 3/16 inch, PHS phillips
49	352-0015-00			2	HOLDER, nylon, coil form
	- - - - - -			-	mounting hardware for each: (not included w/holder)
	213-0045-00			1	SCREW, self-tapping, 4-40 x 5/16 inch, PHS phillips
50	344-0122-00	X14487		4	CLIP, spring
	- - - - - -			-	mounting hardware for each: (not included w/clip)
	211-0504-00			1	SCREW, 6-32 x 1/4 inch BHS
	210-0006-00			1	LOCKWASHER, internal, #6
	210-0407-00			1	NUT, hex, 6-32 x 1/4 inch

CABLE HARNESS & CERAMIC STRIP DETAIL



REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	179-664			1	CABLE HARNESS, focus and intensity
2	179-666			1	CABLE HARNESS, calibrator
3	179-665			1	CABLE HARNESS, 110 volt
4	179-663	5001	6634	1	CABLE HARNESS, indicator
	179-727	6635		1	CABLE HARNESS, indicator
5	124-091			8	STRIP, ceramic, 3/4 inch x 11 notches
	- - - -			-	each strip includes:
	355-046			2	STUD, nylon
	- - - -			-	mounting hardware for each: (not included w/strip)
	361-009			2	SPACER, nylon, .313 inch
6	124-090			8	STRIP, ceramic, 3/4 inch x 9 notches
	- - - -			-	each strip includes:
	355-046			2	STUD, nylon
	- - - -			-	mounting hardware for each: (not inculded w/strip)
	361-009			2	SPACER, nylon, .313 inch
7	124-091			3	STRIP, ceramic, 3/4 inch x 11 notches
	- - - -			-	each strip includes:
	355-046			2	STUD, nylon
	- - - -			-	mounting hardware for each: (not inculded w/strip)
	361-007			2	SPACER, nylon, .063 inch

STANDARD ACCESSORIES



REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	161-0010-00			1	CORD, power
2	103-0013-00			1	ADAPTER, 3 to 2 wire
3	378-0534-00	5001	12399	1	FILTER, green
	378-0544-00	12400	14821	1	FILTER, smoke gray (installed)
	378-0560-00	14822		1	FILTER, smoke gray (installed)
4	387-0935-00	X12400		1	PLATE, protector
5	012-0031-00	X10490	13699	1	CORD, patch
	012-0087-00	13700		1	CORD, patch
6	012-0091-00	X13700		1	CORD, patch
7	012-0092-00	X13700		1	JACK, BNC — post
8	103-0033-00	X7895	13699X	2	ADAPTER, BNC to binding post
- -	070-0342-00			2	MANUAL, instruction (not shown)

©!

ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part Number	Description	S/N Range
		Bulbs	
B601	150-001	Incandescent, #47 Graticule Light	5001-8311
B601	150-031	Incandescent, G.E. #44 Graticule Light	8312-up
B602	150-001	Incandescent, #47 Graticule Light	5001-8311
B602	150-031	Incandescent, G.E. #44 Graticule Light	8312-up
B603	150-018	Incandescent, G.E. #12 Pilot Light	
B856	150-025	Neon, NE-2E	
B857	150-025	Neon, NE-2E	
		Capacitors	

Tolerance ±20% unless otherwise indicated.

Tolerance of all electrolytic capacitors are as follows (with exceptions):

3 V — 50 V = —10%, +250%
51 V — 350 V = —10%, +100%
351 V — 450 V = —10%, +50%

C611	285-510	.01 μf	MT		400 v	
C616	285-510	.01 μf	MT		400 v	
C640A,B	use 290-224	340 μf x 10 μf	EMC		250 v	
C642A,B	use 290-224	340 μf x 10 μf	EMC		250 v	
C644	use 290-224	340 μf x 10 μf	EMC		250 v	
C650	285-510	.01 μf	MT		400 v	
C667	290-002	8 μf	EMT		450 v	
C670	use 285-511	.01 μf	PTM		600 v	
C720	290-166	2 x 2000 μf	EMC		25 v	
C732	use 290-201	100 μf	EMT		15 v	X6360-up
C737	283-026	.2 μf	Disc Type		25 v	
C757	use 290-231	100 μf	EMT		25 v	
C760	281-027	.7-3 pf	Tub.	Var.		
C761	281-027	.7-3 pf	Tub.	Var.		
C801	283-006	.02 μf	Disc Type		600 v	
C803	283-000	.001 μf	Disc Type		500 v	
C807	285-502	.001 μf	MT		1000 v	
C822	283-071	.0068 μf	Disc Type		5000 v	
C830	283-036	.0025 μf	Disc Type		6000 v	5001-12112
C830	283-071	.0068 μf	Disc Type		5000 v	12113-up
C832	283-036	.0025 μf	Disc Type		6000 v	5001-12112
C832	283-071	.0068 μf	Disc Type		5000 v	12113-up
C837	283-036	.0025 μf	Disc Type		6000 v	5001-12112
C837	283-034	.005 μf	Disc Type		4000 v	12113-up
C841	285-519	.047 μf	MT		400 v	
C842	283-071	.0068 μf	Disc Type		5000 v	
C853	283-036	.0025 μf	Disc Type		6000 v	5001-12112
C853	283-034	.005 μf	Disc Type		4000 v	12113-up
C876	290-025	6.25 μf	EMT		300 v	
C878	281-523	100 pf	Cer.		350 v	
C884	281-524	150 pf	Cer.		500 v	
C897	283-000	.001 μf	Disc Type		500 v	

Diodes

Ckt. No.	Tektronix Part Number	Description	S/N Range
D627	*152-107	Silicon Replaceable by 1N647	X12113-up
D640A,B,C,D	*152-047	Silicon Replaceable by 1N2862	
D642A,B,C,D	*152-047	Silicon Replaceable by 1N2862	
D644A,B,C,D	*152-047	Silicon Replaceable by 1N2862	
D663	*152-107	Silicon Replaceable by 1N647	X12113-15429
D663	152-0066-00	Silicon IN3194	15430-up
D664	*152-107	Silicon Replaceable by 1N647	X12113-15429
D664	152-0066-00	Silicon IN3194	15430-up
D720	152-035	Silicon 1N1563A	
D721	152-035	Silicon 1N1563A	
D745	*152-0107-00	Silicon Replaceable by 1N647	X13900-up
D838	152-008	Germanium	5001-5788
D838	*152-047	Silicon Replaceable by 1N2862	5789-up
D839	*152-061	Silicon Tek Spec	5001-5788
D839	*152-047	Silicon Replaceable by 1N2862	5789-up
D852	*152-061	Silicon Tek Spec	5001-5780X

Fuses

F601	159-023	2 Amp 3AG Slo-Blo 117-v oper. 50-60 cycle	5001-10657
F601	159-005	3 Amp 3AG Slo-Blo 117-v opr. 50-60 cycle	10658-up
F601	159-019	1 Amp 3AG Slo-Blo 234-v oper. 50-60 cycle	5001-10657
F601	159-003	1.6 Amp 3AG Slo-Blo 234-v oper. 50-60 cycle	10658-up
F720	159-023	2 Amp 3AG Slo-Blo	

Inductor

L860	Use *108-285	Beam Rotator

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

R601	311-055	50 Ω		Var.	WW	SCALE ILLUM.	5001-8311
R601	311-377	25 Ω	12.5 w	Var.	WW		8312-up
R602	308-142	30 Ω	3 w		WW	5%	5001-8311X
R609	302-106	10 meg	½ w				
R610	302-104	100 k	½ w				
R611	302-102	1 k	½ w				
R612	302-272	2.7 k	½ w				
R616	311-015	10 k		Var.	WW	—100 V	
R617	308-186	80 k	½ w		WW	1%	5001-16359
R617	308-0186-01	80 k	1 w		WW	1%	16360-up
R618	308-226	10 k	½ w		WW	1%	
R619	302-224	220 k	½ w				
R624	302-473	47 k	½ w				
R625	302-222	2.2 k	½ w				
R626	302-184	180 k	½ w				
R627	302-102	1 k	½ w				
R628	308-176	4 k	20 w		WW	5%	
R632	302-102	1 k	½ w				
R633	302-473	47 k	½ w				
R635	301-302	3 k	½ w			5%	
R640	304-100	10 Ω	1 w				
R642	304-100	10 Ω	1 w				

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part Number		Description				S/N Range
R644	304-100	10 Ω	1 w				5001-5949X
R644	304-100	10 Ω	1 w				X6635-up
R650	309-101	330 k	½ w		Prec.	1%	
R651	309-162	250 k	½ w		Prec.	1%	
R652	302-102	1 k	½ w				
R653	302-225	2.2 meg	½ w				
R654	302-474	470 k	½ w				
R655	302-685	6.8 meg	½ w				X6635-up
R656	311-068	500 k	.2 w	Var.		+125 VOLTS	X6635-up
R657	302-684	680 k	½ w				
R658	302-273	27 k	½ w				
R659	302-333	33 k	½ w				
R663	302-102	1 k	½ w				
R664	302-102	1 k	½ w				
R666	308-176	4 k	20 w		WW	5%	
R667	308-176	4 k	20 w		WW	5%	
R670	309-156	1.024 meg	½ w		Prec.	1%	
R671	309-053	333 k	½ w		Prec.	1%	
R672	302-102	1 k	½ w				
R673	302-105	1 meg	½ w				
R675	302-825	8.2 meg	½ w				X6635-up
R676	311-068	500 k	.2 w	Var.		+300 VOLTS	X6635-up
R677	304-224	220 k	1 w				
R678	302-394	390 k	½ w				
R679	302-333	33 k	½ w				
R729	302-823	82 k	½w				X7490-up
R730	311-068	500 k	.2 w	Var.		−12.2 VOLTS	X6635-up
R731	309-104	2.05 k	½ w		Prec.	1%	
R732	310-115	15 k	1 w		Prec.	1%	
R733	302-564	560 k	½ w				X6635-7489
R733	301-394	390 k	½ w			5%	7490-up
R734	302-334	330 k	½ w				
R735	302-272	2.7 k	½ w				
R737	302-151	150 Ω	½ w				
R744	308-231	220 Ω	3 w		WW	5%	
R749	303-0563-00	56 k	1 w			5%	X13900-up
R754	302-471	470 Ω	½ w				
R759	302-104	100 k	½ w				
R770	302-564	560 k	½ w				
R781	316-470	47 Ω	¼ w				X5900-12112X
R782	316-470	47 Ω	¼ w				X5900-12112X
R783	316-470	47 Ω	¼ w				X5900-12112X
R784	316-470	47 Ω	¼ w				X5900-12112X
R801	306-681	680 Ω	2 w				
R802	302-562	5.6 k	½ w				
R803	306-273	27 k	2 w				
R804	302-101	100 Ω	½ w				5001-5949X
R806	302-104	100 k	½ w				
R807	302-472	4.7 k	½ w				
R813	302-101	100 Ω	½ w				
R815	302-474	470 k	½ w				
R816	302-102	1 k	½ w				
R831	302-104	100 k	½ w				
R832	302-106	10 meg	½ w				X5950-up
R833	311-314	2 meg		Var.		INTENSITY	
R834	302-105	1 meg	½ w				

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part Number		Description				S/N Range
R835	Use *050-115	30 meg	2 w		Prec.	5%	5001-7799
R835†	(3) 306-565	5.6 meg	2 w				7800-up
	(2) 306-685	6.8 meg	2 w				
R836	302-223	22 k	½ w	(Nominal value)			
R837	302-471	470 Ω	½ w				X5789-up
R838	301-242	2.4 k	½ w			5%	
R839	302-104	100 k	½ w				
R840	301-125	1.2 meg	½ w			5%	
R841	311-042	2 meg		Var.		HIGH VOLTAGE	
R842	Use *050-118	12 meg	2 w		Prec.	5%	5001-7799
R842†	(2) 306-275	2.7 meg	2 w				7800-up
	(2) 306-335	3.3 meg	2 w				
R844	311-313	5 meg		Var.		FOCUS	
R846	302-225	2.2 meg	½ w				
R849	302-223	22 k	½ w				
R851	302-104	100 k	½ w				
R852	302-273	27 k	½ w				
R853	302-471	470 Ω	½ w				X5789-up
R854	302-105	1 meg	½ w				
R860	311-317	2 x 1 k		Var.		ALIGNMENT	
R861	302-680	68 Ω	½ w				
R862	302-823	82 k	½ w				
R863	302-823	82 k	½ w				
R864	311-206	250 k		Var.		ASTIGMATISM	
R865	311-115	100 k		Var.		GEOMETRY	5001-10637
	311-026	100 k		Var.			10638-up
R870	301-393	39 k	½ w			5%	
R871	311-315	20 k		Var.		CAL. AMPL.	
R872	301-154	150 k	½ w			5%	
R873	302-103	10 k	½ w				
R876	Use 323-0306-00	15 k	½ w		Prec.	1%	
R877	Use 323-0314-00	18.2 k	½ w		Prec.	1%	
R878	Use 323-0455-00	536 k	½ w		Prec.	1%	
R879	Use 323-0389-00	110 k	½ w		Prec.	1%	
R883	305-223	22 k	2 w			5%	
R885	309-121	9.5 k	½ w		Prec.	1%	
R886	309-119	6.375 k	½ w		Prec.	1%	
R887	309-117	2.1 k	½ w		Prec.	1%	
R888	309-116	1.025 k	½ w		Prec.	1%	
R889	309-113	610 Ω	½ w		Prec.	1%	
R890	309-073	200 Ω	½ w		Prec.	1%	
R891	309-112	100 Ω	½ w		Prec.	1%	
R892	309-067	60 Ω	½ w		Prec.	1%	
R893	309-066	40 Ω	½ w		Prec.	1%	
R896	309-045	100 k	½ w		Prec.	1%	
R897	309-112	100 Ω	½ w		Prec.	1%	
R898	309-112	100 Ω	½ w		Prec.	1%	
R899	*308-090	¼ Ω	1 w		WW		

† S/N 7800-up *050-115 may be used
† S/N 7800-up *050-118 may be used

Switches

Ckt. No.	Tektronix Part Number Unwired	Wired	Description		S/N Range
SW601	260-014		Toggle	POWER ON	
SW870	260-253	*262-497	Rotary	CALIBRATOR	
SW854	260-449		Slide	EXT. CRT CATHODE	

Thermal Cutout

TK601	Use 260-157	Thermal Cutout 160°F ±5°F

Transformers

T601	*120-280	L. V. Power
T801	*120-275	H. V. Power

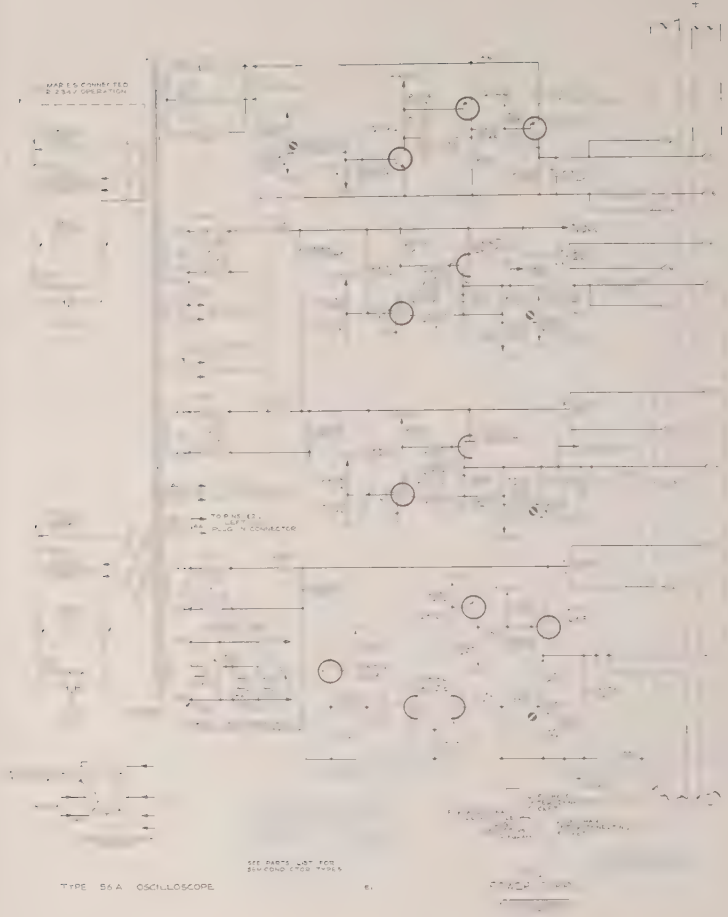
Transistors

Q624	*151-087	Selected from 2N1131
Q734	151-040	2N1302
Q744	151-042	2N1378
Q757	Use 151-0165-00	2N3614

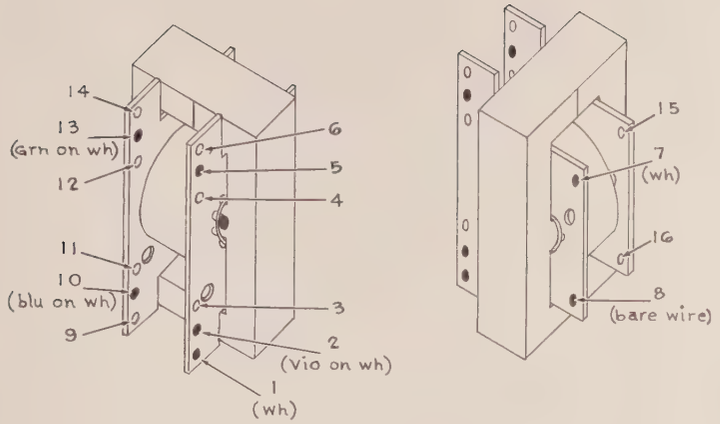
Electron Tubes

V609	154-291	OG3	
V627	154-307	7233	
V634	154-187	6DJ8	
V654	154-022	6AU6	
V667	154-020	6AS7G	
V674	154-022	6AU6	
V800	154-167	6CZ5	
V814	154-046	12BH7	
V822	154-051	5642	
V832	154-051	5642	
V859†	Use *154-0449-00	T5032-31-1 CRT Standard Phosphor	5001-12399
V859	*154-449	T5032-31-1 CRT Standard Phosphor	12400-up
V884	154-278	6BL8	

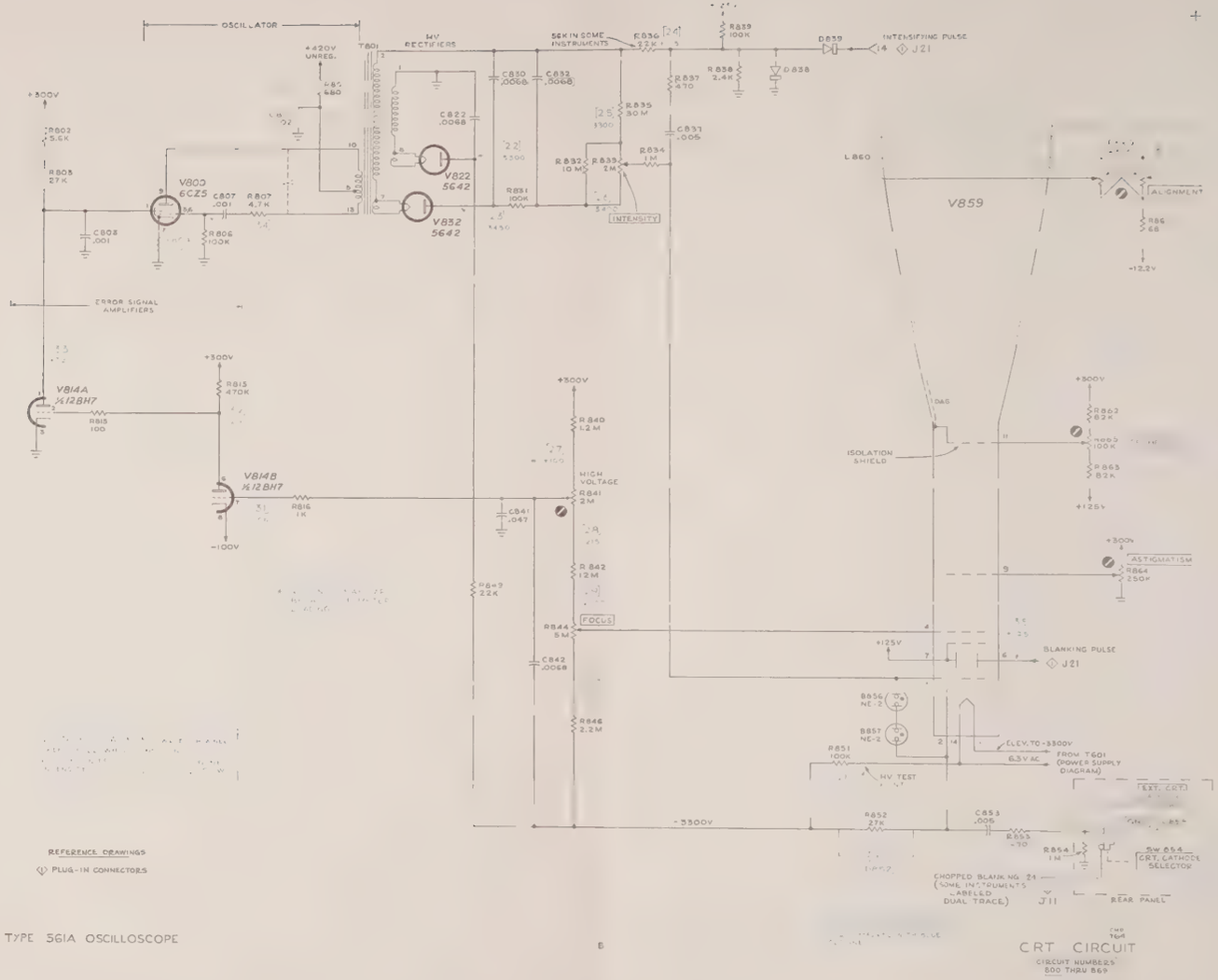
† S/N 5001-12399 add *050-214 Kit



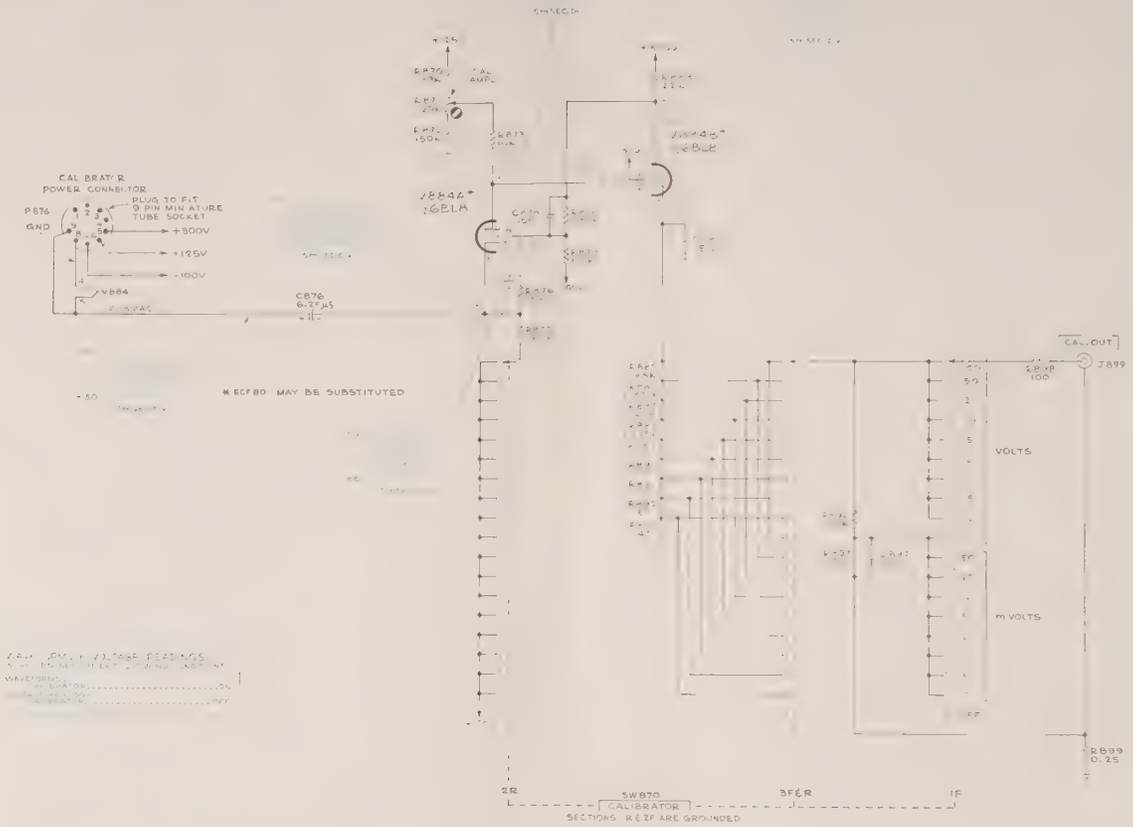
TYPE 56 A OSCILLOSCOPE



T801
TERMINALS & CONNECTIONS



CRT CIRCUIT
CIRCUIT NUMBERS 800 THRU 869

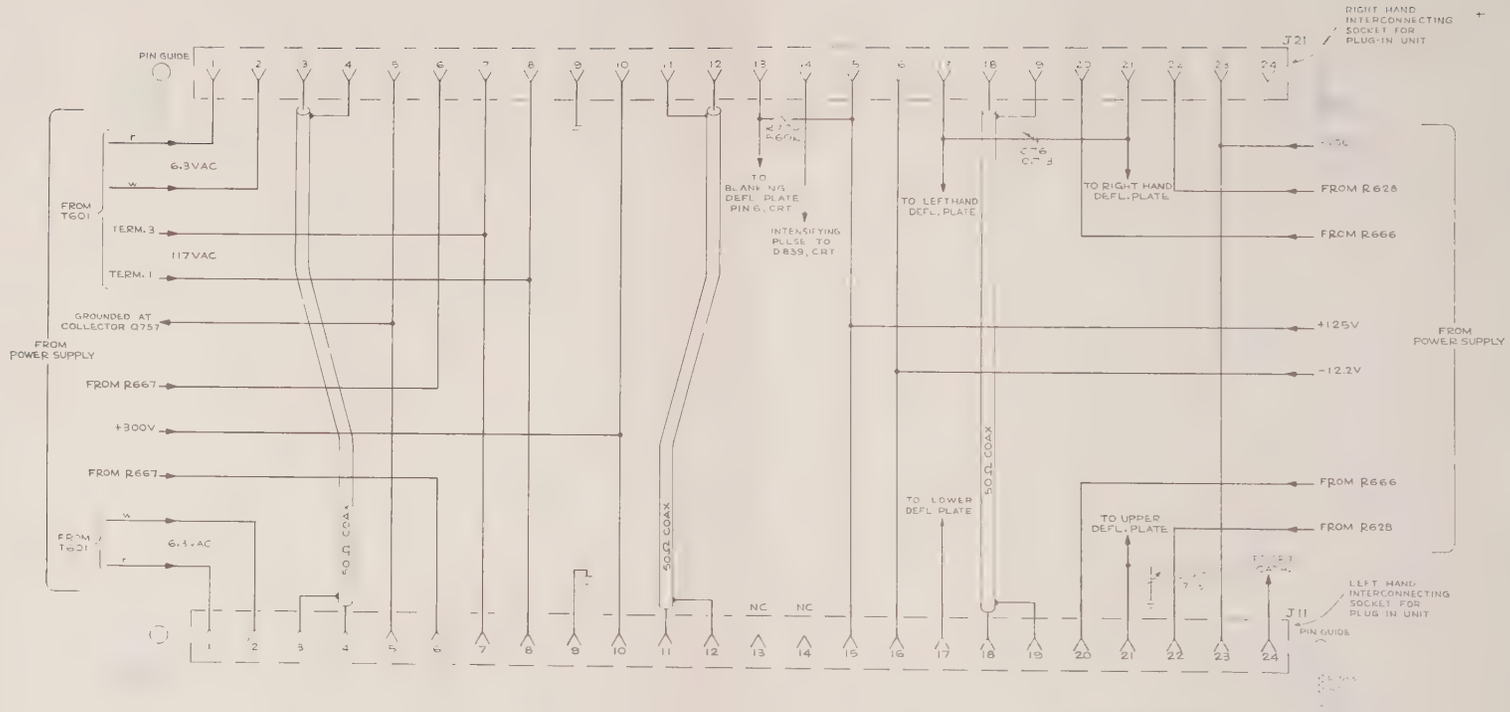


TYPE 561A OSCILLOSCOPE

CALIBRATOR

CIRCUIT NUMBERS
870 THRU 899

266



TYPE 561A OSCILLOSCOPE

PLUG-IN CONNECTORS

MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages. If it does not, your manual is correct as printed.

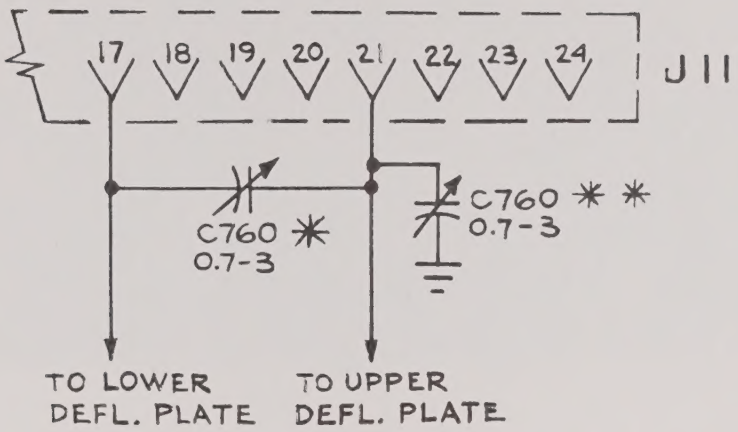
TYPE 561A TENT SN 16500

PARTS LIST CORRECTION

CHANGE TO:

D640A, B, C, D	152-0066-00	Silicon
D642A, B, C, D	152-0066-00	Silicon
D644A, B, C,D	152-0066-00	Silicon
D838	152-0066-00	Silicon
D839	152-0066-00	Silicon

SCHEMATIC CORRECTION



PART. PLUG-IN CONN.

* New location of C760.

** This is the old location of C760. Our test department may select to install C760 at this alternate location.

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